An Investigation on the Relationships between the Knowledge, Attitudes, and Behaviour Dimensions of Environmental Literacy among Urban and Rural Form 4 Students in Sabah, Malaysia

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Abstract:
Over the past 20 years, researchers have explored the status, delivery, and effects of Environmental Education (EE) using various types of national surveys. These surveys have primarily related to curriculum needs in K-12 programs in public schools. In several national surveys, researchers have assessed the level of environmental knowledge or attitudes of students in primary and secondary schools (e.g., Barraza & Walford, 2002; Makki, Abd-El-Khalick, & Boujaoude, 2003; Tuncer, Ertepinar, Tekkaya, & Sungur, 2005). Reviewers of research and evaluation studies have pointed out the limitations of surveys that narrowly focus on environmental knowledge or specific dimensions of environmental affect (e.g., Hines, Hungerford, & Tomera, 1987; Hungerford & Volk, 1998). In response, researchers have developed broader models of environmental literacy. Relatively, few efforts thus far have been made to assess students over this wider range of environmental literacy components (e.g., Chu *et al*, 2007; Kuhlemeier, van der Bergh, & Lagerweij, 1999). The purpose of this study is to evaluate urban and rural Form 4 students' environmental literacy which includes the dimensions of environmental knowledge, attitudes, and behaviors. The ultimate goal of this study is to investigate the probable relationships between these different dimensions of environmental literacy, and their association with students' demographic variables such as gender and school location. This study will involve the administration of the Environmental Literacy Survey (ELS), a version of the Green's (1999) modified Wisconsin Environmental Survey. Descriptive statistics were used to gauge Form 4 students' environmental knowledge, environmental attitudes, and environmental behaviors. Independent samples *t*-test was used to determine if there is a significant difference in environmental literacy based on gender as well as school location. Pearson's product moment correlation analysis and multiple regression analysis were used to investigate the associations between environmental knowledge, environmental attitudes, and environmental behaviors among Form 4 students. This study offers a snapshot of environmental literacy among urban and rural Form 4 students especially in Sabah, Malaysia.

Keywords:
Environmental Literacy, Environmental Knowledge, Environmental Attitudes, Environmental Behaviours, Secondary school students, Urban and rural schools

1. Background of the Study

As far back as the 1972 United Nations Conference in Stockholm, lack of public awareness about the environment has been a topic of international concern. This commitment to raising public environmental awareness was renewed in 1992 at the Earth Summit in Rio de Janeiro and is manifested in Chapter 36 of Agenda 21. In 1977, a United Nations conference was convened in Tbilisi, Georgia that resulted in the Tbilisi Declaration which affirmed the international commitment to international environmental education. The Tbilisi Declaration was reaffirmed at the Thessaloniki Conference on environmental education in 1997. Hence, environmental literacy is the embodiment of this international commitment to raise environmental awareness in citizens around the world. Environmental literacy is more than simple knowledge of environmental and ecological concepts. It also includes the skills necessary to perform sustainable behaviors, the attitude and concern for the environment to provide motivation to perform environmental behaviors. Hence, environmental literacy goes a step further than basic literacy by including environment knowledge as well as attitudes and behaviors that are related to environmental sustainability.

Environmental Education (EE) in schools plays an essential role as a tool for sustainable development. EE in schools is aimed at producing a society that is sensitive towards the environmental issues and possess appropriate knowledge, skills, values, and able to contribute to the solutions of the environmental problems. Environmental literacy is considered the paramount objective of Environmental Education (EE) programs (Disinger & Roth, 1992; Hungerford, Peyton, & Wikle, 1980; Iozzi, Laveault, & Marcinkowski, 1990). Although no formal universal definition exists for environmental literacy, Marcinkowski and Rehrig (1995) and Simmons (1995, 1998) have identified general principles common to most environmental literacy definitions. These include environmental and ecological knowledge, clear positions on environmental issues, cognitive skills to analyze environmental problems, and behavior patterns that are designed to limit individual environmental impact or contribute to broader societal efforts to protect the environment. Hungerford and Volk (1998) argued that EE is fundamentally different from other educational disciplines in that it aspires to influence the behavior of the pupils who study it. This is reflected in the behavioral component in most definitions of environmental literacy.

2. The Study

2.1 Problem Statement

In the Malaysian context, although EE is not taught as a single subject, the concepts and components of EE are integrated across curriculum at all levels of schooling as well as across extra-curricular activities and programs or projects outside schools. Students are expected to develop an awareness and understanding of the importance of the natural environment and the effects of human activities on it, as well as an appreciation for the complexity of the interaction. There is a need to know the level of environmental literacy among students as an indicator of the effectiveness of the EE programs. The information is needed to know whether the mission and vision of the EE programs has been achieved and whether it needs to be changed or continued as it is (McBeth, Hungerford, Marcinkowski, Volk, & Meyers, 2008). Although societal interest and investment in EE is substantial and likely to increase, no researchers have comprehensively assessed environmental literacy among secondary school students especially in the state of Sabah, Malaysia. Hence, this study is crucial due to the inadequate understanding of secondary school students' environmental literacy which includes environmental knowledge, environmental attitudes, and environmental behaviors.

2.2 Objectives of the Study

This study attempts to achieve the following objectives:-

i) To assess environmental knowledge, environmental attitudes, and environmental behaviors among secondary school students;
ii) To ascertain if there is any significant difference in environmental literacy between male and female secondary school students;
iii) To ascertain if there is any significant difference in environmental literacy between urban and rural secondary school students;
iv) To investigate the extent of the relationships between environmental knowledge, environmental attitudes, and environmental behaviors among secondary school students;
v) To investigate the contribution of environmental knowledge and environmental attitudes to environmental behaviors among secondary school students.

2.3 Research Questions

This study attempts to answer the following questions:-

i) What is the level of environmental knowledge, environmental attitudes, and environmental behaviors among secondary school students?
ii) Is there a significant difference in secondary school students' environmental literacy based on gender?
iii) Is there a significant difference in secondary school students' environmental literacy based on school location?
vi) What is the extent of the relationships between environmental knowledge, environmental attitudes, and environmental behaviors among secondary school students?
vii) Do secondary school students' environmental knowledge and environmental attitudes contribute to their environmental behaviors?

2.4 Research Hypotheses

Four null hypotheses formed to be tested in this study are:

i) There is no significant difference in secondary school students' environmental literacy based on gender.
ii) There is no significant difference in secondary school students' environmental literacy based on school location.
iii) There is no significant relationship between environmental knowledge, environmental attitudes, and environmental behaviors among secondary school students.
iv) Secondary school students' environmental knowledge and environmental attitudes do not contribute to their environmental behaviors.

3. Methodology

3.1 Research Design

This was a non-experimental quantitative research. Non-experimental research is a systematic empirical inquiry in which the researcher does not have direct control of independent variables because their manifestations have already occurred or because they are inherently not manipulable. Hence, inferences about relations among variables are made, without direct intervention, from concomitant variation of independent and dependent variables (Johnson & Christensen, 2000). Sample survey method was used to collect data. In this study, the Environmental Literacy Survey (ELS) instrument, a version of the Green's (1999) modified Wisconsin Environmental Survey (WES) was used to measure secondary school students' environmental literacy which includes Environmental Knowledge, Environmental Attitudes, and Environmental Behaviors.

3.2 Research Samples and Sampling Methods

A group of Forn 4 students were selected, by using cluster random sampling technique, from urban and rural secondary schools of Sabah, Malaysia. The distribution of Form 4 students according to gender and school location is illustrated in Table 1 below:

Table 1:
Distribution of Form 4 Students according to Gender and School Location

	n	*%*
Gender		
Male	57	43.8
Female	73	56.2
Total	130	100.0
School Location		
Urban	67	51.5
Rural	63	48.5
Total	130	100.0

3.3 Instrumentation

The Environmental Literacy Survey (ELS) was adapted from the Green's (1999) modified Wisconsin Environmental Survey (WES) for use in measuring secondary school students' environmental literacy levels. The original instrument was adapted from the Wisconsin High School Student Environmental Survey, developed by the Wisconsin Center for Environmental Education. Though the survey was originally designed for use in measuring high school students' environmental literacy, it has been successfully used by at least three researchers (e.g., Green, 1999; Hsu & Roth, 1998, and Todt, 1995) to measure adults' environmental literacy. The ELS consists of three dimensions (affective, behavioral, and cognitive) that are scored separately and then combined to indicate the respondents' environmental literacy level. The survey took respondents approximately 15 minutes to complete.

3.4 Data Collection Procedures

Before administering the ELS instrument, formal permission from the related authorities was sought and obtained. The ELS instrument was personally-administered by the researchers. Secondary school students were gathered in their respective classrooms and the instrument was administered to them concurrently. Students were informed about the nature of the instrument and how the instrument should be answered. In this study, students were instructed to indicate the extent to which they agree or disagree with each statement in Section A; how frequently they do each of the actions mentioned in Section B, and choose the best answer for each of the multiple-choice items in Section C.

3.5 Data Analysis Procedures

The Environmental Knowledge dimension of the ELS refers to the cognitive subscale of the modified Wisconsin Environmental Survey that has been further modified to consist of 15 multiple-choice items that measure the respondents' knowledge of basic ecological concepts, environmental problems, and action strategies. Correct responses were assigned a score of four (4) and incorrect responses a score of zero (0). The lowest score is zero and the highest is 60.

The Environmental Attitudes dimension of the ELS refers to the affective subscale from the modified Wisconsin Environmental Survey which was further modified to consist of 15 items that measure the respondents' attitudes toward environment and efficacy beliefs, some of which can be identified as behavioral intention items. The responses were scored utilizing a Likert-type scale (Strongly Disagree to Strongly Agree) with the least desired environmental attitudes being assigned a zero (0) and the most

preferred response being assigned a four (4). The higher a respondent's score, the higher the level of environmental attitudes of the respondent. The lowest possible total score is zero and the highest possible score is 60.

The Environmental Behavior dimension of the ELS refers to the behavioral subscale from the modified Wisconsin Environmental Survey which was further modified to consist of 15 items that measure the respondents' participation in environmental behaviors. The responses were scored utilizing a Likert-type scale (Never to Almost Always) with no demonstrated environmental behavioral response being assigned a zero (0) and the most demonstrated environmental behavioral response being assigned a four (4). The higher the score, the more actively engaged the respondent is in environmental behaviors. The lowest possible total score is zero and the highest possible total score is 60. Environmental literacy composit score was determined by adding up the three scores from the three subscales for each respondent. The lowest possible score is zero and the highest is 180.

On the other hand, as an effort to ensure all the quantitative data were drawn from a normally distributed population, graphical measures such as histogram, stem-and-leaf plot, normal Q-Q plot, and detrended normal Q-Q plot were plotted for each of the variables studied. Furthermore, numerical measures such as skewness and kurtosis were used to identify any deviations from normal distributions (Hair, Anderson, Tatham, & Black, 1998; Miles & Shevlin, 2001). After the assumptions of using parametric techniques in analyzing quantitative data were met, independent sample *t*-test was used to test the stated null hypotheses at a predetermined significance level, alpha = .05. Independent sample *t*-test was used to determine if there is a significant difference in secondary school students' environmental literacy based on gender and school location.

Pearson's correlation was used to identify possible significant linear relationships among the knowledge, attitudes, and behaviors dimensions of environmental literacy. Pearson's product-moment correlation coefficients (*r*) were calculated to show the strength of the linear relationships among the variables studied. A multiple regresssion analysis was conducted to test the contribution of environmental knowledge and environmental attitudes to environmental behaviors when all other independent variables were held constant. Stepwise multiple regression analysis was used to ascertain whether environmental knowledge and environmental attitudes can make a significant prediction on secondary school students' environmental behaviors. Stepwise variables selection method was used in order to get a parsimonious model which can explain most of the variance in the dependent variable by using the least number of independent variables. Assumptions namely normality, homoscedasticity, linearity, and independence were met prior to multiple regression analysis. Besides that, distance statistics (leverage measure and Cook's distance) and influence statistics (DfBeta and DfFit) were used to identify any outliers and influential observations in the data. To detect multicollinearity among the independent variables used in this study, correlation matrices, Tolerance (T) and Variance Inflation Factor (VIF) were used (Hair *et al*., 1998).

4. Research Findings and Discussion

4.1 Validity and Reliability of the Environmental Literacy Survey (ELS) Instrument

The instrument that the ELS was based on has been tested extensively for validity both for construction and content by the Wisconsin Center for Environmental Education. The content was based on the Environmental Literacy Framework that was developed by the Wisconsin Center for Environmental Education, which is very similar to the National Association for Environmental Education Guidelines. Pilot test were conducted to test individual item reliability. A large statewide sample was then administered after which final modifications were made to the survey (Green, 1999).

The reliability of each subscale of the Wisconsin High School Student Environmental Survey was calculated based on the 1994 administration of the instrument by the Wisconsin Center for Environmental Education (Peri, 1996). For the Environmental Attitudes (affective subscale), coefficient alpha equals .91; for the Environmental Behavior (behavior subscale), coefficient alpha equals .88, and for Environmental

Knowledge (cognitive subscale), coefficient alpha equals .84. These numbers indicated that each dimension of the ELS was reliable (Green, 1999). In this study, the Cronbach's Alpha reliability of the ELS instrument is reported as in Table 2.

Table 2: Cronbach's Alpha Reliability of the Environmental Literacy Survey Instrument

Dimension	Item No.	Cronbach's Alpha Reliability
Environmental Knowledge (Cognitive)	C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11, C12, C13, C14, C15	.419
Environmental Attitudes (Affective)	A1, A2, A3, A4, A5, A6, A7, A8, A9, A10, A11, A12, A13, A14, A15	.459
Environmental Behaviors (Behavior)	B1, B2, B3, B4, B5, B6, B7, B8, B9, B10, B11, B12, B13, B14, B15	.762
Overall		.605

4.2 Secondary School Students' Environmental Literacy

Table 3: Mean and Standard Deviation of Secondary School Students' Environmental Literacy

Dimension	*n*	Number of Items	Maximum Possible Scores	*M*	*SD*
Environmental Knowledge	130	15	60	25.48	9.465
Environmental Attitudes	130	15	60	43.08	4.460
Environmental Behaviors	130	15	60	40.78	8.227
Overall	130	45	180	109.35	14.471

The mean and standard deviation of secondary school students' environmental literacy in descending order were reported as follows: Environmental attitudes (M = 43.08, SD = 4.460), Environmental behaviors (M = 40.78, SD = 8.227), and Environmental knowledge (M = 25.48, SD = 9.465). The results of this study were similar to other studies (Kibert, 2000; Connell *et al*., 1999; Diekmann & Preisendorfer, 1998; Kuhlemeier *et al*., 1999; Scott & Willits, 1994) which showed that environmental attitudes are the highest, followed by environmental behaviors whereas environmental knowledge is the lowest. Surprisingly, Form 4 sudents in this study did not exhibit impressive scores for the knowledge dimension of environmental literacy. This result is striking because knowledge is the environmental-literacy category most emphasized in the curriculum. The poor results with respect to several key environmental topics (Table 4) may reflect the fact that the actual time spent on EE in schools is far below that recommended by the Malaysian Ministry of Education. Environmental behavior is regarded as the desired end point of EE efforts (Hungerford & Volk, 1998; Sivek, 2002). The environmental attitudes and environmental behaviors of secondary school students in the present study were, in general, high (Table 5 and Table 6). These findings are consistent with research conducted among students in the Netherlands (Kuhlemeier *et al*., 1999) and Turkey (Tuncer *et al*., 2005).

Table 4: Secondary School Students' Responses on the Environmental Knowledge Items

No	Environmental Knowledge Items	Correct (%)	Incorrect (%)
C1	A food web consists of Answer: many interconnected food chains.	**44.6**	55.4
C2	All of the same individual organisms that live on the ground in a particular forest share the same Answer: habitat	55.4	44.6
C3	Wolves eat deer. Does this interaction have any beneficial effects on the deer population as a whole? Answers: Yes, the wolves help keep the deer population size controlled. Yes, the wolves help keep the population strong since the fastest, most alert deer survive.	**30.8**	69.2
C4	Based upon major ecological principles, we should conclude that Answer: the human species will last as long as there is a balanced ecosystem that will support human life.	51.5	48.5
C5	The process of photosynthesis in green plants Answer: changes light energy into chemical energy.	**33.1**	66.9
C6	Which of the following terms is used to describe all of the natural living and non-living interacting features of a given area? Answer: Ecosystem	60.8	39.2
C7	A particular aquatic ecosystem is contaminated by a chemical which tends to remain stored in body fat. The highest concentration of this chemical would most likely be found in which group of organisms in the ecosystem? Answer: Minnows	**20.0**	80.0
C8	Which of the following phrases refers to the potential ability of a system to support population growth without harming the environment? Answer: Carrying capacity	**20.8**	79.2
C9	Some insecticides that were once effective in killing insects no longer work very well. This is because Answer: insects with natural resistance survived and multiplied	56.2	43.8
C10	Which of the following contributes to air pollution at the surface of the earth, and acts as a shield against ultraviolet rays in upper atmosphere? Answer: Ozone	66.9	33.1
C11	The main source(s) of emissions that have been identified as contributing to acid deposition (acid rain) in the United States are Answer: automobiles and coal burning power plants.	50.0	50.0
C12	The rate of species' extinction is higher now than at any time since the period of the dinosaurs' extinction. The main cause of this rapid decline in biodiversity is Answer: changes in the Earth's atmosphere due to human activities.	**38.5**	61.5
C13	A major nuclear accident occurred in 1986 at the _____ nuclear power plant. Answer: Chernobyl	**34.6**	65.4
C14	Which of the following is most likely to help endangered species? Answer: Maintain large protected natural areas where they live.	**40.8**	59.2
C15	In the long term, which of the following would be the best way to lessen the problem of solid waste? Answer: Reuse materials for other purposes rather than throwing them out	**33.1**	66.9

Table 5: Secondary School Students' Responses on the Environmental Attitudes Items

No.	Statement	Responses			
		SD (%)	D (%)	A (%)	SA (%)
A1*	When I am outside, I usually don't notice the natural things around me like flowers, trees, and clouds.	**40.8**	40.0	13.8	5.4
A2*	I'm not interested in reading about nature or the environment.	16.9	**51.5**	24.6	6.9
A3*	I think most of the concern about environmental problems has been exaggerated.	18.5	**37.7**	36.2	7.7
A4*	A community's pollution regulations should not interfere with industrial growth and development.	26.2	**36.2**	29.2	8.5
A5	More controls should be placed on industry and agriculture to protect the quality of the environment, even if it means that thing I purchase will cost more.	5.4	14.6	**49.2**	30.8
A6*	I am not concerned about the fact that the world's deserts are increasing in size.	32.3	**44.6**	16.9	6.2
A7*	There are already enough laws to protect the environment.	34.6	**41.5**	10.0	13.8
A8*	I don't think that recycling is worth all the trouble it takes.	20.8	30.0	**42.3**	6.9
A9	More land should be set aside for wildlife habitats.	4.6	22.3	**38.5**	34.6
A10	I am concerned about how much waste is produced in this country.	2.3	16.2	**44.6**	36.9
A11	Laws should be passed and enforced that protect the quality of life in the future even if it means that individual freedoms are limited.	6.2	33.1	**39.2**	21.5
A12*	I am not concerned about the rate of species extinction in the world.	**37.7**	32.3	22.3	7.7
A13	I am concerned about environmental health hazards such as those caused by air or water pollution.	4.6	10.8	**47.7**	36.9
A14	I believe that I can contribute to the solution of environmental issues by my actions.	10,0	27.7	**45.4**	16.9
A15*	It's too hard to change my friends' minds about doing things to help the environment (for example: recycling).	6.9	25.4	**43.8**	23.8

*negatively-worded items

Table 6: Secondary School Students' Responses on the Environmental Behaviors Items

No.	Statement	Responses				
		Never(%)	Almost never(%)	Sometimes(%)	Often(%)	Amost always(%
B1	I turn off lights and appliances when they are not being used to conserve electricity.	4.6	3.1	25.4	29.2	**37.7**
B2	I talk to people that I notice doing something that harms the environment in an effort to persuade that person to stop the activity. (For example, try to talk to a friend into recycling a soda can instead of throwing them in the trash).	11.5	23.1	**47.7**	8.5	9.2
B3	I walk, take public transportation, or ride a bike instead of using a car in order to help protect the environment.	17.7	24.6	**33.1**	14.6	10.0
B4	I make an effort to reduce the amount of goods I consume.	10.8	18.5	**43.1**	20.0	7.7
B5	I set a positive environmental example for my friends to follow.	9.2	16.9	**45.4**	20.0	8.5
B6	I support candidate for political offices who are concerned about environmental problems and issues.	10.8	16.2	**31.5**	21.5	20.0
B7	If I see an aluminium can on the ground when I'm out walking, I pick it up and take it with me.	30.0	15.4	**34.6**	12.3	7.7
B8	I recycle paper, glass and/or metal waste products at home or at school.	11.5	16.2	**31.5**	24.6	16.2

B9	I avoid purchasing products that have a negative impact on the environment.	19.2	13.8	**36.2**	22.3	8.5
B10	I talk to my family and friends about what they can do to help solve environmental problems	25.4	19.2	**36.9**	11.5	6.9
B11	I write or call politicians to express my views about environmental issues.	**53.1**	26.9	12.3	3.1	4.6
B12	I make a point of reading newspaper and magazine articles about the environment.	19.2	23.1	**32.3**	13.1	12.3
B13	I purchase one product over another product because it is packaged in reusable, returnable or recyclable containers or packages.	12.3	16.2	**35.4**	23.1	13.1
B14	I send letters to the newspaper about environmental problems or issues.	**65.4**	15.4	12.3	5.4	1.5
B15	I have reported environmental problems or violations that I have noticed to the proper authorities.	**56.2**	23.8	13.8	4.6	1.5

4.3 Mean Differences in Secondary School Students' Environmental Literacy based on Gender

Table 7: Mean Differences in Secondary School Students' Environmental Literacy based on Gender

Dimension	Gender	*n*	*M*	*SD*	Mean Difference	*t*	*df*	*p*
Environmental Knowledge	Male	57	26.39	9.910	1.619	.967	128	.335
	Female	73	24.77	9.108				
Environmental Attitudes	Male	57	43.51	4.520	.755	.958	128	.340
	Female	73	42.75	4.415				
Environmental Behaviors	Male	57	42.37	7.509	2.820	1.961	128	.052
	Female	73	39.55	8.596				
Environmental Literacy	Male	57	112.26	14.438	5.195	2.056	128	.042
	Female	73	107.07	14.180				

The first null hypothesis was tested by using the independent sample *t*-test at a specified significance level, alpha = .05. As shown in Table 7 and Figure 1, independent sample *t*-test results showed that there were no significant difference in secondary school students' environmental knowledge, environment attitudes and environmental behaviors based on gender. However, there was a significant difference in environmental literacy between male and female secondary school students. Generally, male secondary school students demonstrated higher environmental knowledge, more positive environmental attitudes, more environmental behaviours as compared to their female counterparts. However, the differences were not statistically significant.

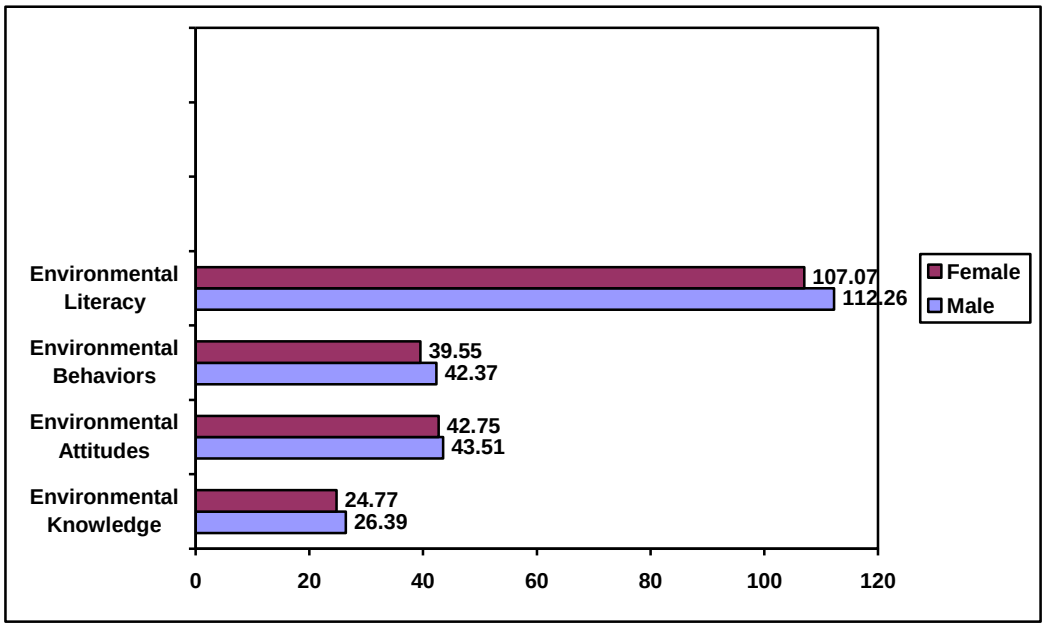

Figure 1: Mean differences in Secondary School Students' Environmental Literacy based on Gender

The results of this study showed some contridictions with Kibert's (2000) study. In Kibert's (2000) study, gender differences in environmental attitudes have been detected with females generally demonstrating more positive attitudes than males. Likewise, males have been shown to have more environmental knowledge than females. At the alpha = .05, there was also a significant difference in environmental behaviors with females scoring higher than males. Kibert's (2000) study supported the studies presented in the literature review. Gifford *et al*. (1982/83) found in their study of undergraduates that males scored higher in environmental knowledge than females and that more females than males reported they would do something about environmental problems. Likewise, Hausbeck *et al*. (1992) reported that females expressed more positive environmental attitudes than males, and males had slightly more environmental knowledge than females. Scott and Willits (1994) found that females were more likely to exhibit environmentally protective consumer behaviors, but men were more likely to participate in environmental political action. To summarize, in prior studies that studied male and female differences in the components of environmental literacy, it was found that females generally demonstrated more concern and positive attitudes than males towards the environment whereas males typically performed higher on the knowledge component (Eagles & Demare, 1999; Dietz, 1998; Gifford *et al*. 1982/83; Hausbeck *et al*. 1992; Scott & Willits, 1994).

4.4 Mean Differences in Secondary School Students' Environmental Literacy based on School Location

Table 8: Mean Differences in Secondary School Students' Environmental Literacy based on School Location

Dimensions	School location	*n*	*M*	*SD*	Mean Difference	*t*	*df*	*p*
Environmental Knowledge	Urban	67	25.37	8.932	-.214	-.128	128	.898
	Rural	63	25.59	10.072				
Environmental Attitudes	Urban	67	43.90	4.359	1.673	2.168	128	.032
	Rural	63	42.22	4.438				
Environmental Behaviors	Urban	67	40.49	8.601	-.603	-.416	128	.678
	Rural	63	41.10	7.867				
Environmental Literacy	Urban	67	109.76	14.792	.856	.336	128	.737
	Rural	63	108.90	14.227				

The second null hypothesis was tested by using the independent sample *t*-test at a specified significance level, alpha = .05. As shown in Table 8 and Figure 2, independent sample *t*-test results showed that there were no significant difference in secondary school students' environmental knowledge, environmental behaviors, and environmental literacy based on school location except for environmental attitudes. Generally, rural secondary school students demonstrated more environmental knowledge, more environmental behaviors as compared to their urban school counterparts whereas urban secondary school students showed more positive environmental attitudes and more environmental literacy than their rural school counterparts. However, the difference in environmental literacy was not statistically significant.

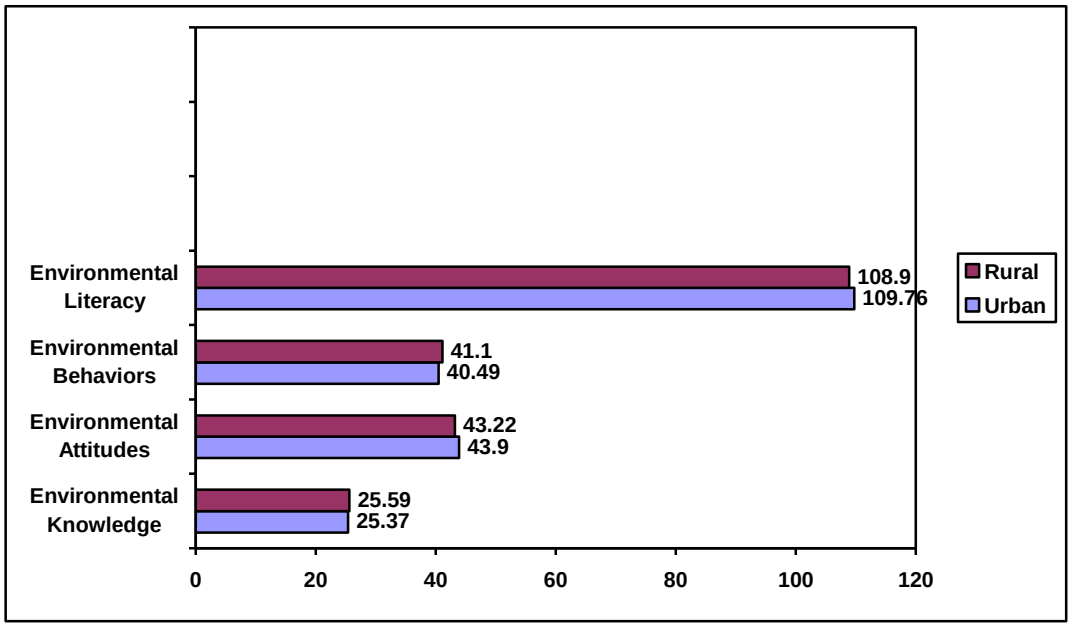

Figure 2: Mean differences in Secondary School Students' Environmental Literacy based on School Location

4.5 The Relationships between Environmental Knowledge, Environmental Attitudes, and Environmental Behaviors among Secondary School Students

The third null hypothesis was tested by using the Pearson's product-moment correlation at a specified significance level, $p < .05$. Correlation analysis results in Table 9 showed that there were low to moderate, positive correlation among environmental knowledge, environmental attitudes, and environmental behaviors. Thus, these findings had failed to reject the third null hypothesis. On the other hand, all the three dimensions of environmental literacy were moderately, positively, and significantly correlated with secondary school students' environmental literacy.

Table 9: Pearson's Product Moment Correlations between Environmental Knowledge, Environmental Attitudes, and Environmental Behaviors

	Environmental Knowledge	Environment Attitudes	Environment Bahaviors	Environmental Literacy
Environmental Knowledge	-	.130 *p*=.141	.031 *p*=.728	.712** *p*<.0005
Environmental Attitudes	.130 *p*=.141	-	.224* *p*=.010	.521** *p*<.0005
Environmental Behaviors	.031 *p*=.728	.224* *p*=.010	-	.658** *p*<.0005
Environmental Literacy	.712** *p*<.0005	.521** *p*<.0005	658** *p*<.0005	-

These findings were consistent with previous research findings. A key debate in the EE literature revolves around the relations between knowledge, attitudes, and behavior (e.g., Kibert, 2000; Courtenay-Hall & Rogers, 2002; Hungerford & Volk, 1998; Kaiser *et al*., 1999; Kollmuss & Agyeman, 2002; Kuhlemeier *et al*., 1999; Makki *et al*., 2003; Marcinkowski, 1998b; Olli *et al*., 2001; Said *et al*., 2007; Scott & Willits, 1994; Simmons, 1998; Ungar, 1994).

In Kibert's (2000) study, the initial correlations showed an insignificant relationship between knowledge and behavior. Knowledge and attitude had a weak correlation. Attitude and behavior components demonstrated a moderate correlation. According to Kibert (2000), for both 6^{th} and 12^{th} graders, the overall environmental-behavior scores were unrelated to environmental-knowledge scores and, in fact, were negatively related to knowledge in a multivariate regression that included attitudes. Behavior was strongly related to attitudes in the 6^{th} grade and moderately related in the 12^{th} grade. With the exception of one question in the 6^{th} grade, Kibert found no single knowledge question to be related to behavior scores. The lack of high correlation between knowledge and behavior has been discovered and considered in other contexts (Kuhlemeier *et al*., 1999; Makki *et al*., 2003; Scott & Willits, 1994). These findings supported the results from other environmental literacy studies recounted in the literature review. Attitudes and knowledge have historically been found to have weak to moderate correlations. Behavior and attitudes have weak to moderate correlations dependent on what types of attitude (self-efficacy, locus of control, and consciousness) and behavior (self-reported or observed) are being related. Knowledge and behavior have been reported to have no or weak correlations. This is generally thought to be because the affect of knowledge is attenuated by attitudes, situational factors and subjective norms.

As indicated by the theoretical models of behavior change, knowledge and behavior are not expected to have a strong correlation. In the Kuhlemeier *et al*. (1999) study of environmental knowledge, attitudes and behaviors in ninth graders in Holland, they found a weak correlation (r = .20) between

knowledge and behavior. In the Hines *et al*. (1987) study, they also examined the relationship of knowledge and behavior and found an overall correlation of r = .299 from the 17 studies that reported this data. Those studies that drew from a population of individuals in environmental organizations had a correlation of r = .691 as compared with members of the general public (r = .268) or children (r = .192). These studies support Azjen's (1988, p.134) notion that knowledge is a pre-condition for behavior: "At the most basic level of explanation, behavior is assumed to be a function of salient information, or beliefs, relevant to the behavior." Kaiser *et al*. (1999, p.4) remark that "factual knowledge should not be related with ecological behavior strongly because its influence is attenuated both by environmental attitude and intention." Attitudes are moderate predictors of behavior and in order to have a positive environmental attitude, an individual must first have the relevant knowledge to hold that attitude.

As Kaiser *et al*. (1999, p.4) remark, "factual knowledge about the environment is a precondition of one's environmental attitude." The relationship between knowledge and attitude is a complex one and is not fully understood (Zimmerman, 1996). In Petrzelka and Korsching's (1996) study of environmental attitudes and behavior toward sustainable agriculture, they found that changing the knowledge and beliefs of farmers about sustainable agriculture also changed their attitudes. In the Kuhlemeier *et al*. (1999) study of environmental literacy in Dutch ninth grade students, they found a weak correlation between knowledge and attitude. In Bradley *et al*.'s (1999) study of knowledge and environmental attitude in high school students, they found that after an environmental science course, students had higher environmental knowledge and attitudes between the pre- and posttests. In both the pre- and posttests, students with higher knowledge scores also had higher attitude scores when compared with students who had lower environmental knowledge scores. Similarly, Mangas and Martinez's (1997) study regarding university students enrolled in an elective environmental education course showed that students' environmental knowledge increased at the end of the course and was accompanied by an increase in environmental attitudes.

Hines *et al*. (1987) found that attitude and behavior had an overall moderate correlation of r = .347. This finding is substantiated by Kaiser *et al*. (1999, p.4) who found that, "the usual findings reveal either a moderate relationship between environmental attitude and ecological behavior or a weak relationship." In the Kuhlemeier *et al*. (1999) study of environmental literacy in Dutch ninth graders, they found a moderate correlation (r = .36) between attitude and behaviors. Counter-intuitively, Hines *et al*. (1987) found that when the behavior was actually observed rather than self-reported, the attitude-behavior correlation went up to r = .427. Other studies have assumed that self-reported behavior is usually over-reported. The results from the Hines *et al*. (1987) study may have been enhanced because the attitudes and behaviors that were correlated were specifically related. Conversely, Scott and Willits (1994), in their study of Pennsylvanians' environmental attitudes and behaviors, found that attitudes were predictive of behaviors but the correlation were weak at r = .21.

4.6 The Influence of Environmental Knowledge and Environmental Attitudes on Environmental Behaviors

The fourth null hypothesis was tested by using stepwise multiple regression analysis technique. Results (Table 10) showed that environmental attitudes significantly contributed to secondary school students' environmental behaviors [$F(1,128) = 6.789$, p =.010]. Based on the R^2 value, environmental attitudes can only explain 5.0% of the variance in secondary school students' environmental behaviors. Thus, this finding had failed to reject the fourth null hypothesis. According to Kibert (2000), although knowledge by itself was not significantly related to behavior, when both knowledge and attitudes were included as independent variables in a regression with behavior as a response, Kibert found that both had a significant effect on behavior for both 6^{th} and 12^{th} grades, suggesting that there is an interaction effect between knowledge and attitudes that influences behavioral outcomes. In both cases, attitude had a strong positive relation to behavior, and, more surprisingly, knowledge had a weak negative relation to behavior. In other words, with control for attitude, environmental knowledge was correlated with somewhat decreased environmental behavior.

Table 10:
Multiple Regression Analysis Results for Environmental Knowledge and Environmental Attitudes on Environmental Behaviors (n = 130)

Predictor variables	*B*	*SE*	*β*	ΔR^2	*t*	*p*
Constant	22.947	6.882			3.334	.001
Environmental Attitudes	.414	.159	.224		2.606	.010

** $p < .01$

Multiple R = .224
R^2 = .050
Adjusted R^2 = .043
SEE = 8.049
F (1, 128) = 6.789; p = .010

5. Conclusion

This study offers a snapshot of environmental literacy among secondary school students in the state of Sabah, Malaysia. The findings of this study revealed large gaps in environmental knowledge and a significant drop in environmental behavior and attitudes among secondary school students. The results suggest that the intended objectives of environmental education in Malaysia have not been achieved. The authors call for additional research to identify ways to improve environmental education in the Malaysian public schools. Further research is necessary to understand how the various components of environmental literacy in reality interact, particularly in different subpopulations, so that an effective course of action for environmental literacy programs can be established. Building on existing tendencies for environmental literacy to naturally increase will allow secondary school students to deliberately engage in responsible environmental behavior. Giving the increasing severity of these problems and the public's role in solving them, upgrading EE programs in the country's schools should be a central part of future environmental policy efforts at both the national and local levels. This will require additional research about existing and experimental pedagogical techniques in the field and openness to new EE initiatives and curricula.

Previous researchers have found that environmental knowledge, attitudes, and behavior vary across cultures and societies (Barraza & Walford, 2002; Deng *et al*., 2006; Hershey & Hill, 1977-1978; Johnson *et al*., 2004; Milfont & Gouveia, 2006; Olli *et al*., 2001; Van Petegem & Blieck, 2006) and that some attitude scales are highly affected by respondent characteristics such as gender, residence, education, income, age, and political orientation (Tarrant & Cordell, 1997). Further researchers should attempt to broaden the notion of environmental literacy, especially in a multicultural society such as Malaysia, to reduce cultural bias in surveys as much as possible. Although it is expected that a culturally sensitive approach will be reflected in EE programs, the refinement process should be done in light of the finding of Cheak, Volk, and Hungerford (2002) that similar EE techniques work in cross-cultural situations.

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ENVIRONMENTAL LITERACY SURVEY INSTRUMENT

Instructions for Section A:

Please indicate how you feel about each statement below. There are no right or wrong answers. Read each statement carefully. Circle the number in the space on your answer sheet for the number that best indicates the extent to which you agree or disagree with each statement, using the following key:

(1) Strongly Disagree
(2) Disagree
(3) Agree
(4) Strongly Agree

No.	Statement	Key			
A1	When I am outside, I usually don't notice the natural things around me like flowers, trees, and clouds.	(1)	(2)	(3)	(4)
A2	I'm not interested in reading about nature or the environment.	(1)	(2)	(3)	(4)
A3	I think most of the concern about environmental problems has been exaggerated.	(1)	(2)	(3)	(4)
A4	A community's pollution regulations should not interfere with industrial growth and development.	(1)	(2)	(3)	(4)
A5	More controls should be placed on industry and agriculture to protect the quality of the environment, even if it means that thing I purchase will cost more.	(1)	(2)	(3)	(4)
A6	I am not concerned about the fact that the world's deserts are increasing in size.	(1)	(2)	(3)	(4)
A7	There are already enough laws to protect the environment.	(1)	(2)	(3)	(4)
A8	I don't think that recycling is worth all the trouble it takes.	(1)	(2)	(3)	(4)
A9	More land should be set aside for wildlife habitats.	(1)	(2)	(3)	(4)
A10	I am concerned about how much waste is produced in this country.	(1)	(2)	(3)	(4)
A11	Laws should be passed and enforced that protect the quality of life in the future even if it means that individual freedoms are limited.	(1)	(2)	(3)	(4)
A12	I am not concerned about the rate of species extinction in the world.	(1)	(2)	(3)	(4)
A13	I am concerned about environmental health hazards such as those caused by air or water pollution.	(1)	(2)	(3)	(4)
A14	I believe that I can contribute to the solution of environmental issues by my actions.	(1)	(2)	(3)	(4)
A15	It's too hard to change my friends' minds about doing things to help the environment (for example: recycling).	(1)	(2)	(3)	(4)

Instructions for Section B:

For the following group of statements, please indicate how frequently you do each of the actions mentioned. Be honest, there are no right or wrong answers. Circle the number on your answer sheet for the number that is closest to your answer, using the following key:

(1) Never
(2) Almost never
(3) Sometimes
(4) Often
(5) Almost always

No.	Statement	Key				
B1	I turn off lights and appliances when they are not being used to conserve electricity.	(1)	(2)	(3)	(4)	(5)
B2	I talk to people that I notice doing something that harms the environment in an effort to persuade that person to stop the activity. (For example, try to talk to a friend into recycling a soda can instead of throwing them in the trash).	(1)	(2)	(3)	(4)	(5)
B3	I walk, take public transportation, or ride a bike instead of using a car in order to help protect the environment.	(1)	(2)	(3)	(4)	(5)
B4	I make an effort to reduce the amount of goods I consume.	(1)	(2)	(3)	(4)	(5)
B5	I set a positive environmental example for my friends to follow.	(1)	(2)	(3)	(4)	(5)
B6	I support candidate for political offices who are concerned about environmental problems and issues.	(1)	(2)	(3)	(4)	(5)
B7	If I see an aluminium can on the ground when I'm out walking, I pick it up and take it with me.	(1)	(2)	(3)	(4)	(5)
B8	I recycle paper, glass and/or metal waste products at home or at school.	(1)	(2)	(3)	(4)	(5)
B9	I avoid purchasing products that have a negative impact on the environment.	(1)	(2)	(3)	(4)	(5)
B10	I talk to my family and friends about what they can do to help solve environmental problems	(1)	(2)	(3)	(4)	(5)
B11	I write or call politicians to express my views about environmental issues.	(1)	(2)	(3)	(4)	(5)
B12	I make a point of reading newspaper and magazine articles about the environment.	(1)	(2)	(3)	(4)	(5)
B13	I purchase one product over another product because it is packaged in reusable, returnable or recyclable containers or packages.	(1)	(2)	(3)	(4)	(5)
B14	I send letters to the newspaper about environmental problems or issues.	(1)	(2)	(3)	(4)	(5)
B15	I have reported environmental problems or violations that I have noticed to the proper authorities.	(1)	(2)	(3)	(4)	(5)

Instructions for Section C:

For each of the following questions, choose the best answer. Circle the number corresponding to your answer on your answer sheet.

C1. A food web consists of

1) the animals that eat other animals in a community.
2) all the herbivores and carnivores in an ecosystem.
3) many interconnected food chains.
4) all the consumers in an ecosystems.

C2. All of the same individual organisms that live on the ground in a particular forest share the same

1) niche.
2) habitat.
3) life-style.
4) food source.

C3. Wolves eat deer. Does this interaction have any beneficial effects on the deer population as a whole?

1) Yes, the wolves help keep the deer population size controlled.
2) No. The deer population is only harmed.
3) Yes, the wolves help keep the population strong since the fastest, most alert deer survive.
4) Both (1) and (3).

C4. Based upon major ecological principles, we should conclude that

1) humans are a climax species that will last indefinitely.
2) the human species will soon become extinct; nothing we can do will prevent this.
3) the human species will last as long as there is a balanced ecosystem that will support human life.
4) there is no way of predicting what will happen to the human species; ecological principles do not apply to humans.

C5. The process of photosynthesis in green plants

1) uses sunlight to burn energy in plants.
2) changes light energy into chemical energy.
3) changes chlorophyll into sugar.
4) is a process used to burn sugar stored in plants so the plants can grow.

C6. Which of the following terms is used to describe all of the natural living and non-living interacting features of a given area?

1) Habitat
2) Community
3) Biodiversity
4) Ecosystem

C7. A particular aquatic ecosystem is contaminated by a chemical which tends to remain stored in body fat. The highest concentration of this chemical would most likely be found in which group of organisms in the ecosystem?

1) Plant life
2) Minnows
3) Fish that eat insects and plants
4) Fish-eating birds

C8. Which of the following phrases refers to the potential ability of a system to support population growth without harming the environment?

1) Carrying capacity
2) Species loading
3) Non-sustainable growth
4) All of the above

C9. Some insecticides that were once effective in killing insects no longer work very well. This is because

1) new insect species develop every day.
2) the wrong kind of insecticides were used.
3) insects with natural resistance survived and multiplied.
4) the insects produced many more offspring than the insecticide could kill.

C10. Which of the following contributes to air pollution at the surface of the earth, and acts as a shield against ultraviolet rays in upper atmosphere?

1) Nitrous oxide
2) Methane
3) Ozone
4) Sulfur dioxide

C11. The main source(s) of emissions that have been identified as contributing to acid deposition (acid rain) in the United States are

1) volcanoes and forest fires.
2) petroleum refineries.
3) automobiles and coal burning power plants.
4) aerosol sprays and refrigerant leakage.

C12. The rate of species' extinction is higher now than at any time since the period of the dinosaurs' extinction. The **main** cause of this rapid decline in biodiversity is

1) habitat alteration by humans.
2) the illegal poaching or collecting of animals and plants.
3) changes in the Earth's atmosphere due to human activities.
4) hunting by humans for food or sport.

C13. A major nuclear accident occurred in 1986 at the _____ nuclear power plant.

1) Belgrade
2) Nagasaki
3) Chernobyl
4) Three Mile Island

C14. Which of the following is **most** likely to help endangered species?

1) Outlaw the sale or possession of endangered species or products made from them (skins, furs, ivory, etc.)
2) Create breeding programs in zoos for endangered animals.
3) Use farming methods which do not damage habitat.
4) Maintain large protected natural areas where they live.

C15. **In the long term**, which of the following would be the **best** way to lessen the problem of solid waste?

1) Incinerate waste materials
2) Reduce the amount of materials being consumed
3) Reuse materials for other purposes rather than throwing them out
4) Recycle materials that can be used again

This is the end of the survey.

Thank you for your participation!