SECONDARY SCHOOL STUDENTS' ENERGY LITERACY: EFFECT OF GENDER AND SCHOOL LOCATION

Lay Yoon Fah [a], Khoo Chwee Hoon [b] , Elyna Tony Munting [c] , Collins Andrew Chong [d]
[a] School of Education and Social Development, Universiti Malaysia Sabah, Malaysia.
[b] Science and Mathematics Department, Teacher Education Institute- Kent Campus, Tuaran, Sabah, Malaysia.
[C] SMK. Apin-Apin, Keningau, Sabah, Malaysia.
[d] SM. St. Michael, Penampang, Sabah, Malaysia.
[a] Corresponding author: layyoonfah@yahoo.com.my

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Abstract: Energy is the "underlying currency that governs everything humans do with each other and with the natural environment that supports them." Our reliance on energy-rich sources of fossil fuels has created the underpinnings of modern society, enabling mobility, industrial growth, domestic comfort, unprecedented lavish food supply, and economic prosperity. As we move into a future with limited fossil fuels resources and worsening environmental conditions, our society is faced with defining new directions with respect to energy consumption, resources, and independence. Energy literacy encompasses three dimensions: Content knowledge (cognitive), sensitivity and attitude (affective); and intentions/behaviours. An informed, energy-literate public is more likely to be engaged in the decision making process, and will be better equipped to make thoughtful, responsible energy-related decisions, choices, and actions. Unfortunately, a number of studies have shown that people are generally ill-prepared to actively contribute to solving our energy problems, largely because they lack energy-related knowledge and awareness. Hence, the primary purpose of this study is to investigate the effect of gender and school location of secondary school students on their energy literacy. The secondary purpose is to investigate if there is a correlation among the afore-mentioned components of energy literacy. The ultimate goal of this study is to investigate the contribution of students' energy-related knowledge and attitudes on their energy-related behaviors. This was a non-experimental quantitative research. Sample survey method was used to collect data by using 'Energy Literacy Questionnaire'. Independent samples *t*-test, Pearson product-moment correlation, and multiple linear regression were used to test the stated null hypotheses at a predetermined significance level, alpha = .05. A broad and efficient measure of energy literacy for secondary school students may prove useful for determining baseline energy literacy levels among groups of students, as well as to assess the effectiveness of energy education programmes for improving energy literacy. Such assessment would provide valuable programmes feedback, enabling greater strides toward better educational programmes, wider implementation of these programmes in our classrooms, and improved energy literacy.

Keywords: Energy literacy, Energy-related Attitudes, Energy-related Behaviors, Energy-related Knowledge, Gender, School location, Secondary school students

INTRODUCTION

Energy is the "underlying currency that governs everything humans do with each other and with the natural environment that supports them." Our reliance on energy-rich sources of fossil fuels has created the underpinnings of modern society, enabling mobility, industrial growth, domestic comfort, unprecedented lavish food supply, and economic prosperity. As we move into a future with limited fossil fuels resources and worsening environmental conditions, societies in the developed world are faced with defining new directions with respect to energy consumption, energy resources, and a shift toward energy independence (DeWaters & Powers, 2011).

The energy path will be determined not just by professionals and politicians, but by every citizen who participates in society-through the energy choices that are integral to decisions of daily life. The term energy literacy embodies more than just content knowledge, it also includes a "citizenship understanding" of energy that encompasses affective and behavioral aspects (DeWaters & Powers, 2007). An energy literate individual is one who has a sound conceptual knowledge base as well as a thorough understanding of how energy is used in everyday life, understands the impact that energy production and consumption have on all spheres of our environment and society, is sympathetic to the need for energy conservation and the need to develop alternatives to fossil fuel-based resources, is cognizant of the impact that personal energy-related decisions and actions have on the global community, and – most importantly - strives to make choices and exhibit behaviors that reflect these attitudes with respect to energy resource development and energy consumption. An informed, energy-literate public is more likely to be engaged in the decision making process, and will be better equipped to make thoughtful, responsible energy-related decisions, choices, and actions. Energy literacy, which encompasses broad content knowledge as well as affective and behavioral characteristics, will empower people to make appropriate energy-related choices and embrace changes in the way they harness and consume energy. Hence, energy literacy is now more than ever an important life skill with which to empower today's students as well as the general public.

Problem Statement

A number of studies have shown that energy-related knowledge in the US is disparagingly low (e.g., Barrow & Morrisey, 1989; Bittle *et al*., 2009; Curry *et al*., 2007; Farhar, 1996; Gambro & Switzky, 1999; NEETF, 2002; Shelton, 2008, DeWaters & Powers, 2011). For example, the National Environmental Education & Training Foundation (NEETF) found in a 2001 telephone survey among 1500 adults that, while many Americans tended to overestimate their energy knowledge, just 12% could pass a basic energy quiz (NEETF, 2002). In DeWaters and Powers' (2011) study to measure energy literacy of secondary students in New York State, USA, energy literacy was measured with a written questionnaire completed by 2708 secondary students. Results indicated that students are concerned about energy problems (affective subscale mean 73% of the maximum attainable score), yet relatively low cognitive (42% correct) and behavioral (65% of the maximum) scores suggested that students may lack the knowledge and skills they need to effectively contribute toward solutions of energy-related issues.

In the Malaysian context, although energy literacy is not taught as a single subject, the concepts and components of energy literacy are integrated across curriculum at all levels of schooling as well as across extra-curricular activities and programmes or projects outside schools. Students are expected to develop an awareness and understanding of the importance of the energy-related issues 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 energy literacy among students as an indicator of the effectiveness of the energy literacy efforts. The information is needed to know whether the mission and vision of the energy literacy efforts has been achieved and whether it needs to be changed or continued as it is. Although societal interest and investment in energy literacy is substantial and likely to increase, no researchers have comprehensively assessed energy literacy among Malaysian secondary school students especially in the state of Sabah, Malaysia. Hence, this study is crucial due to the inadequate understanding of secondary school students' energy literacy in terms of three domains i.e. cognitive (knowledge), affective (attitudes, values), and behavioral domains.

Objectives of the Study

This study attempts to achieve the following objectives: (a) To assess energy literacy in terms of cognitive, affective, and behavioral domains among secondary school students (b) To ascertain if there is any significant difference in energy literacy according to students' gender (c) To ascertain if there is any significant difference in energy literacy according to school location (d) To investigate the extent of the relationships among the three domains of energy literacy (cognitive, affective, behavioral) among secondary school students (e) To investigate the contribution of cognitive and affective domains of energy literacy on behavioral domain of energy literacy among secondary school students.

Research Questions

This study attempts to answer the following questions: (a) How do secondary school students perform on the three domains of energy literacy (cognitive, affective, and behavioral)? (b) Is there a significant difference in energy literacy based on students' gender? (c) Is there a significant difference in energy literacy based on school location? (d) What is the extent of the relationships among secondary students' energy-related attitudes and values, behaviors, and cognitive understanding of broad energy-related topics? (e) Do secondary school students' cognitive and affective domains of energy literacy contribute to the behavioral domain of their energy literacy?

Research Hypotheses

Four null hypotheses formed to be tested in this study are: (a) There is no significant difference in energy literacy based on students' gender. (b) There is no significant difference in energy literacy based on school location. (c) There is no significant relationship among the three domains of energy literacy (cognitive, affective, behavioral) among secondary school students. (d) Secondary school students' cognitive and affective domains of energy literacy do not contribute to the behavioral domain of their energy literacy.

METHODOLOGY

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, a modified version of the Energy Literacy Questionnaire (ELQ) instrument (DeWaters & Powers, 2008) was used to measure secondary school students' energy literacy in terms of cognitive, affective, and behavioral domains.

Research Samples and Sampling Methods

The respondents of this study were Form 2 students, randomly selected by cluster random sampling technique, from rural and urban secondary schools of Sabah, Malaysia. The distribution of Form 2 students according to gender and school location is illustrated in Table 1.

Instrumentation

An instrument has been developed to measure energy literacy among New York State (NYS) secondary students (DeWaters & Powers, 2008). The 'Energy Literacy Questionnaire' (ELQ) is a written questionnaire designed for classroom administration and is closely aligned with criteria that describe energy literacy in terms of students' broad energy-related knowledge and cognitive skills, affective aspects such attitudes and values, and behaviors. The instrument was pilot-tested among 1700 NYS secondary students, and was shown to be a valid and reliable quantitative measure. The study described in this paper uses the modified version of the Energy Literacy Questionnaire to improve our understanding of energy literacy levels among Malaysian secondary school students especially in the state of Sabah, Malaysia.

The 'Energy Literacy Questionnaire' contains three subscales to encompass energy-related affective (17 items), behavioral (10 items), and cognitive aspects (30 items), with four self-efficacy items embedded within the affective subscales. The affective and behavioral subscales use a 5-point Likert-type response scale with one neutral response. The cognitive subscales use 5-option multiple choice questions to cover eight main topic areas, which encompass basic scientific energy concepts as well as the "citizenship knowledge" of energy that is crucial to everyday life, in addition to cognitive skills such as critical thinking and analysis. The topic areas include: Saving energy; energy forms, conversions, and units' home energy use; basic energy concepts; energy resources; critical analysis about renewable resources; environmental impacts; and energy-related societal issue. The Energy Literacy Questionnaire was developed according to established psychometric principles and methodologies in the sociological and educational sciences (e.g., Abdel-Gaid *et al*., 1986; Benson & Clark, 1982; DeVellis, 2003; Qaqish, 2006). The internal consistency reliability of each subscale, as measured by Cronbach's alpha, is .79 (cognitive), .83 (affective), and .78 (behavioral), all satisfying generally accepted criteria for internal consistency.

Data Collection Procedures

Before administering the ELQ 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. Respondents were informed about the nature of the instrument and how the instrument should be answered.

Data Analysis Procedures

Students' responses on the questionnaire were converted to numerical scores according to the particular subscale: Cognitive items were assigned one point for each correct answer and zero points for each incorrect or blank response, and Likert-type responses in the affective and behavioral subscales were converted to numerical values according to a predetermined preferred direction of response in order to calculate summated rating totals for each subscale. Values for each Likert item ranged from one (least preferred response) to five (most preferred response).

Table 1: Distribution of Form 2 Students according to Gender and School Location

	n	*%*
Gender		
Male	131	44.9
Female	161	55.1
School Location		
Rural	154	52.7
Urban	138	47.3
Total	292	100.0

Table 2: Reliability Analysis of Energy Literacy Questionnaire

	Cognitive	Affective	Behavioral
Average Item Difficulty[a]	.322	-	-
Cronbach's alpha reliability	.496	.845	.775

[a] Item difficulty is fraction of respondents answering each question correctly

Secondary School Students' Energy Literacy

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

Domain	n^b	Number of Items	Maximum Attainable Scores	% of the Maximum Scores	*M*	Average[c] item mean	*SD*	*Average item SD*
Cognitive	285	30	30	32.66	9.47	.33	3.340	.115
Affective	283	17	85	72.87	61.94	3.64	11.924	.701
Behavioral	291	10	50	71.38	35.69	3.57	7.736	.774
Overall	276	57	165	65.17	106.88	1.91	18.730	.334

[b]The response rate for each subscale (*n*) varies because respondents were eliminated for a particular subscale if more than half of the response were blank. Thus, a single respondent could have acceptable results for one, two, or all three subscales; [c]Average item mean = Scale mean divided by the number of items in a scale

Blank responses in these two subscales were omitted case-wise from the analysis. Responses to each of the three subscales were analyzed separately: Student scores were summed across each subscale, with maximum score of 30 on the cognitive, 85 on the affective, and 50 on the behavioral subscales. In addition to the summated ratings, item mean responses (ranging from 1 to 5) were calculated for Likert-type affective and behavioral subscales, and the percent positive response rates, equal to the percentage of students responding with a 4 or 5 ("strongly agree / agree moderatey" affective subscale; "almost always / quite frequently" behavioral subscale) were calculated for individual affective and behavioral items. Total scores for each subscale were converted to percent correct (or percent of the maximum score, for Likert-type items), established a common metric to simplify comparison between the three subscales.

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 determine if there is a significant difference in secondary school students' energy literacy based on gender and school location at a predetermined significance level of .05. Correlation was used to identify any possible significant linear relationships between the cognitive, affective, and behavioral domain of energy literacy. In relation to this, 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 investigate the contribution of cognitive and affective domain to the behavioral domain of energy literacy when all other independent variables were held constant. Stepwise multiple regression analysis was used to ascertain if cognitive and affective domain of energy literacy can make a significant prediction on secondary school students' energy-related 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).

RESULTS AND DISCUSSION

Validity and Reliability of the Energy Literacy Questionnaire (ELQ) Instrument

The 'Energy Literacy Questionnaire' (ELQ) (DeWaters & Powers, 2008) is a written questionnaire designed for classroom administration and is closely aligned with criteria that describe energy literacy in terms of students' broad energy-related knowledge and cognitive skills, affective aspects such attitudes and values, and behaviors. The instrument was shown to be a valid and reliable quantitative measure. The internal consistency reliability of each subscale, as measured by Cronbach's alpha, is .79 (cognitive), .83 (affective), and .78 (behavioral), all satisfying generally accepted criteria for internal consistency. In this study, the average item difficulty and Cronbach's Alpha reliability of the ELQ instrument is reported as in Table 2. Each of the three subscales appears to be internally consistent, as indicated by Cronbach's alpha values that range from 0.496 to 0.845.

The percentages of the maximum attainable scores of secondary school students' energy literacy in descending order were reported as follows: affective domain (72.87%), behavioral domain (71.38%), and cognitive domain (32.66%). The survey results indicate that, overall, the energy literacy level of this large sample of secondary school students is discouragingly low, particularly with respect to their performance on cognitive questions. In general, the overall student performance on each subscale, with students consistently scoring lowest on the cognitive and highest of the affective subscales, are consistent with earlier findings from the study of DeWaters and Powers (2011). DeWaters and Powers (2011) found that students are concerned about energy problems (affective subscale mean 73% of the maximum attainable score), yet relatively low cognitive (42% correct) and behavioral (65% of the maximum scores) suggest that students may lack the knowledge and skills they need to effectively contribute toward solutions. Table 4, 5, and 6 (Appendix) show secondary school students' responses on the energy-related knowledge, energy-related attitudes, and energy-related behaviors items.

On average secondary students' scores on the affective subscale, while not particularly high, are indeed much better than cognitive or behavioral scores.

Mean Differences in Secondary School Students' Energy Literacy based on Gender

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

Domain	Gender	*n*	*M*	*SD*	Mean Difference	*t*	*df*	*p*
Cognitive	Male	126	9.49	3.782	.033	.080	232.329	.936
	Female	159	9.46	2.957				
Affective	Male	124	61.74	12.344	-.346	-.242	281	.809
	Female	159	62.09	11.624				
Behavioral	Male	130	36.01	7.503	.573	.627	289	.531
	Female	161	35.43	7.933				
Energy Literacy	Male	119	106.93	19.195	.086	.038	274	.970
	Female	157	106.85	18.431				

Mean Differences in Secondary School Students' Energy Literacy based on School Location

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

Domain	School Location	*n*	*M*	*SD*	Mean Difference	*t*	*df*	*p*
Cognitve	Urban	152	9.88	3.158	.874	2.219	283	.027*
	Rural	133	9.01	3.491				
Affective	Urban	151	59.24	13.859	-5.784	-4.325	249.434	<.0005*
	Rural	132	65.02	8.256				
Behavioral	Urban	154	34.25	8.301	-3.053	-3.464	286.504	.001*
	Rural	137	37.31	6.718				
Energy Literacy	Urban	149	103.09	21.827	-8.251	-3.878	246.647	<.0005*
	Rural	127	111.34	13.000				

Table 9: Pearson's Product Moment Correlations among Cognitive, Affective, and Behavioral Domain of Energy Literacy

	Cognitive	Affective	Behavioral	Energy Literacy
Cognitive	-	.210** *p*<.0005 *n*=276	.117* *p*=.050 *n*=284	.363** *p*<.0005 *n*=276
Affective		-	.580** *p*<.0005 *n*=283	.926** *p*<.0005 *n*=276
Behavioral			-	.818** *p*<.0005 *n*=276

The students generally acknowledge the existence of an energy problem and accept the need to conserve energy and increase the use of renewable resources. Students' generally positive attitudes and values regarding energy are apparent.

Most students agreed that saving energy is important (83.9%),that Malaysian should conserve more energy (75.7%) and should make more of our electricity from renewable energy resources (63.9%). However, their agreement drops substantially if an increase in cost is involved (44.8%). Students also expressed a willingness to be part of the solution: 78% agreed that they would do more to save energy if they knew how, they believe that they can contribute to solving the energy problems by making appropriate energy-related choices and actions (66.8%), and they believe that they can contribute to solving energy problems by working with others (70.5%).

Although students "say" they would do more, their responses on the behavioral subscale did not generally reflect their positive attitudes (Table 6). Similar to findings from earlier studies among American consumers (e.g., Bang *et al*., 2000; Costanzo *et al*.,1986; Farhar, 1996; Murphy, 2002), there appears to be a discrepancy between students' attitudes and their actions. For example, survey research by Costanzo *et al*. (1986) found that consumers who indicated conservation as the single most important strategy for improving our energy future were no more likely than others to engage in energy-conservation behaviors. An older study by Milstein (1977) found that, while the majority of the American public was aware of the Nation's energy problems, and most indicated that they preferred to save fuel by carpooling, using public transport, or reducing highway speed, few actually reported doing these things. Like the subjects of these earlier studies, the students who participated in this study seem to be concerned about the energy problems faced by their society, yet they apparently lack the knowledge and skills to work effectively toward a solution.

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, independent sample *t*-test results showed that there was no significant difference in secondary school students' cognitive, affective, behavioral domain of energy literacy and energy literacy based on gender. Hence, these findings had failed to reject the first null hypothesis. Generally, male secondary school students demonstrated more energy-related knowledge, more energy-related behaviors and higher energy literacy as compared to their female counterparts. Female secondary school students showed more positive energy-related attitudes than their male counterparts. However, the differences were not statistically significant.

DeWaters and Powers (2011) found that females had significantly more positive energy-related attitudes and values than males, yet there was no difference in their cognitive or behavior scores. Gender differences were only apparent in the affective portion of the survey, with females showing a significantly greater positive attitudes and values toward energy issues than males. Earlier studies have also shown that females tend to have a greater positive attitude toward energy issues than males (e.g., Ayers, 1977; Barrow & Morrisey, 1987; Lawrenz & Dantchik, 1985), are more concerned with the need for energy conservation, and more strongly recognize the importance of individual efforts (Kuhn, 1979). For example, Ayers (1977) found females to be more cautious in their feelings toward the production of electricity. Kuhn (1979) attributed the observed gender effects to differences in the "attitudes and value systems" of the subjects.

Like several other studies (e.g., Barrow & Morrisey, 1989; Gambro & Switzky, 1999), the study by Lawrenz (1983) also found gender disparities in energy and environmentally-related knowledge. These previous findings reflect general trends of gender differentiation in science achievement, and increased differentiation as students progress through school, that is well documented (e.g., American Association of University Women, 1998; Clewell & Campbell, 2002; Frehill *et al*., 2005; Haertel *et al*., 1981). The lack of gender-based cognitive differences in this current study is encouraging, and will be corroborated in the future as the survey is applied to a greater variety of student groups.

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, independent sample *t*-test results showed that there was significant difference in cognitive, affective, and behavioral domain of energy literacy and energy literacy based on school location. Hence, these findins had failed to reject the second null hypothesis. Generally, urban secondary school students demonstrated higher energy-related knowledge as compared to their rural secondary school counterparts. Rural secondary school students demonstrated more positive energy-related attitudes, more energy-related behaviors, and more energy-literate as compared to their urban secondary school counterparts.

Table 10: Multiple Regression Results for the Contribution of Cognitive and Affective Domain to the Behavioral Domain of Energy Literacy (n = 276)

Predictor variables	*B*	*SE*	*β*	ΔR^2	*t*	*p*
Constant	11.815	1.999			5.912	<.0005
Cognitive						
Affective	.385	.032	.591	.349	12.131	<.0005

** $p < .01$;
Multiple $R = .591$; $R^2 = .349$; Adjusted $R^2 = .347$; SEE = 6.322; F (1, 274) = 147.169; p <.0005

The Relationships among Cognitive, Affective, and Behavioral Domain of Energy Literacy

The third null hypothesis was tested by using Pearson's product-moment correlation at a specified significance level, $p < .05$. Correlation analysis results in Table 9 showed that there was low and significant, positive correlation among cognitive, affective, and behavioral domain of energy literacy and energy literacy. Thus, these findings had rejected the third null hypothesis successfully. On the other hand, all the three dimensions of energy literacy were positively correlated with secondary school students' energy literacy.

Among all the different aspects of energy literacy investigated (cognitive, affective, behavior), knowledge is the one factor that is least likely to be associated with the other components of energy literacy. These findings support the complex interactions between the many factors that influence energy-related behaviors and emphasize the importance of taking a broad educational approach that targets not just content knowledge but students' attitudes, values, and behaviors as well, to improve students' overall energy literacy.

According to DeWaters and Powers (2011), intercorrelations between groups of questions indicate energy-related behaviors are more strongly related to affect than to knowledge. These findings underscore the need for education that improves energy literacy by impacting student attitudes, values and behaviors, as well as broad content knowledge. Affect and behavior are more closely correlated than knowledge and behavior.

Early models of environmental behavior assumed, in the simplest sense, the widely held position that education and knowledge lead to changes in attitudes and values, which in turn foster action or behavior. In fact, a handful of studies provide evidence that support the relationship between knowledge of and attitudes toward environmental issues (e.g., Costanzo *et al*., 1986; Dunlop, 1979; Murphy, 2002). Furthermore, early behavior models developed by Fishbein and Ajzen (1975) and modified by Ajzen (1991) hypothesized that behavior is predicted by a person's beliefs, attitudes, subjective norm, and perceived behavioral control, or feelings of self-efficacy. However, the majority of research into environmental behavior has not supported the quasi-linear cause-and-effect models that link knowledge and attitude to behavior. Most findings indicate that the relationship is complex, not necessarily one-directional, and is influenced by other factors such as positive/negative feedback, social norms, economic situations, values, and beliefs (e.g., Hungerford & Volk, 1990; Newhouse, 1990; Stern, 1992, 2000; Hines *et al*., 1987; Owen & Driffill, 2008).

The Contribution of Cognitive and Affective Domain to the Behavioral Domain of Energy Literacy among Secondary School Students

The fourth null hypothesis was tested by using stepwise multiple regression analysis technique. Results (Table 10) showed that affective domain of energy literacy significantly contributed to secondary school students' energy-related behaviors [$F(1,274) = 147.169$, p <.0005]. Based on the R^2 value, affective domain of energy literacy can only explain 34.9% of the variance in secondary school students' energy-related behaviors. Thus, this finding had rejected the fourth null hypothesis successfully.

The role of student affect in determining responsible energy-related behavior cannot be overlooked. If energy literacy encompasses not only knowledge but attitudes, values, decisions, and action (Kuhn, 1979), then one of the primary goals of energy education is to foster positive attitudes toward energy conservation (Lawrenz & Dantchik, 1985) and to improve students' critical thinking and decision-making skills. Studies that show positive changes in energy-related behaviors after participating in an educational program (e.g., Ramsey & Hungerford, 1989; Volk & Cheak, 2003; Zografakis *et al*., 2008) often involve programs that use relevant projects, case studies, decision-making exercises, and action strategies to emphasize a shift in student values, beliefs, and attitudes. The results described in this study tend to suggest that Malaysian educational system could be doing more to impact student attitudes toward energy issues, which may in turn help improve their conservation behaviors.

CONCLUSION

Our intent is that the answers to the research questions will inform the future development of energy-related educational curricular and materials, thereby improving students' overall energy literacy and empowering them to be more engaged in energy-related decisions as they become adults. This study has shown that energy literacy levels among Malaysian secondary school students especially in the state of Sabah are discouragingly low. Scores were particularly low on topical questions related to current events, home energy use, and energy conservation. These results emphasize the need for improved energy education programmes in the Malaysian public school, with broader coverage of topics related to current events and practical issues, such as the way we use energy in everyday life. The next generation of standards for science education (NAS, 2010) should include criteria that embrace broad energy literacy with benchmarks related not just to science-related energy content but also recognizing the importance of practical energy-related knowledge, decision making skills, value judgments, ethical and moral dimensions, and issues of personal responsibility related to energy resource development and consumption.

High correlations between students' energy-related affect and their energy consumption behaviors, in contrast with low correlations between cognitive and behavioral aspects, suggest that effective educational programs should target not just content knowledge, but should also strive to impact student attitudes, beliefs, and values. Energy curricula should be hands-on, inquiry-based, experiential, engaging, and real-world problem solving, providing an avenue for students to learn content-based material while they are engaged in projects that relate to their own lives. Besides that, curricula should use relevant projects, case studies, decision-making exercises, and action strategies to emphasize a shift in student values, beliefs, and attitudes (Ramsey & Hungerford, 1989; Volk & Cheak, 2003; Zografakis *et al*., 2008).

Our results suggest that secondary school would do well to include more energy-related curricula that emphasize practical knowledge and societal implications, and that encourage students to explore issues in these areas. Schools cannot discard the importance of including education that encourages students' broad "citizenship-based" understanding of energy in order to ensure that they become fully energy literate. These recommendations are similar to those made decades ago (e.g., Kuhn, 1979), after a previous energy crisis in the US. The lack of changes in educational standards seems to have prevented significant progress towards energy literacy.

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