Level of Awareness on Low Carbon Society Concept among Secondary School Students

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Abstract

The establishment of Low Carbon Society (LCS) is aimed at reducing anthropogenic greenhouse gases emission (specifically carbon dioxide) without compromising the economic and social development in developing countries like Malaysia. Formal education plays an important role in catalyzing lifestyle change required to transform our society into LCS. This study aims to understand the level of awareness on LCS concept among secondary school students, and to propose the integration of LCS concepts into school Physics curriculum. A self-reporting questionnaire was developed and distributed to 466 Form Four Science stream students from seven schools in the area of Iskandar Malaysia which is moving towards LCS. The Physics Curriculum Specification and textbooks were analysed qualitatively for LCS components. The result showed that students' level of awareness and knowledge on the concept of LCS is low. Four learning areas in the Physics curriculum were identified to be related to the components of LCS. However information presented in the textbooks are limited to factual knowledge and unrelated to current climate issues. Additional information is proposed to be taught alongside the identified learning areas to promote awareness of LCS and also to equip students with the knowledge to make informed decision and consequently choose more sustainable lifestyle.

Abstrak

Pembinaan Masyarakat Karbon Rendah atau Low Carbon Society (LCS) adalah bertujuan untuk mengurangkan pembebasan gas rumah hijau antropogenik (khususnya karbon dioksida) tanpa menjejaskan pembangunan ekonomi dan sosial di negara-negara membangun seperti Malaysia. Pendidikan formal memainkan peranan yang penting untuk menggalakkan perubahan gaya hidup bagi mengubah masyarakat kita menjadi LCS. Kajian ini bertujuan untuk memahami tahap kesedaran mengenai konsep LCS dalam kalangan pelajar sekolah menengah dan mencadangkan integrasi konsep LCS ke dalam kurikulum Fizik sekolah di Iskandar Malaysia yang sedang bergerak ke arah pembinaan LCS. Satu soal selidik dibina dan diedarkan kepada 466 pelajar Tingkatan Empat aliran Sains di tujuh buah sekolah di kawasan Iskandar Malaysia. Spesifikasi Kurikulum Fizik dan buku teks dianalisa secara kualitatif bagi menentukan komponen LCS yang sedia ada dan yang perlu diterapkan. Keputusan analisis menunjukkan bahawa tahap kesedaran dan pengetahuan pelajar mengenai konsep LCS adalah rendah. Empat bidang pembelajaran dalam kurikulum Fizik yang berkaitan dengan komponen LCS telah dikenal pasti. Walau bagaimanapun, maklumat dalam buku teks terhad kepada pengetahuan fakta. Maklumat tambahan dicadangkan untuk diajar bersama dengan bidang-bidang pembelajaran yang telah dikenalpasti untuk meningkatkan kesedaran LCS dan juga untuk melengkapkan pelajar dengan pengetahuan untuk membuat keputusan yang berdasarkan penilaian yang kritikal dan seterusnya memilih gaya hidup yang lebih lestari.

INTRODUCTION

The effect of greenhouse gases (GHG) from anthropogenic activities on the Earth's climate and its negative impact on our natural environment and human society are widely reported. Carbon dioxide (CO_2) is the most significant anthropogenic greenhouse gas emitted in urban areas (Ho & Fong, 2007). One of the two major treaties produced in the Earth Summit in year 1992 is to reduce the emission of gases leading to global warming to a safe level. In a follow-up conference held in Kyoto, Japan in 1997, an agreement, named the Kyoto Protocol was signed by 160 countries, which calls for reduction of emission of about 5 percent below 1990 baseline by year 2012. Since then many global movements to stabilize global warming has been initiated (Mongillo, 2004).

Low Carbon Society

Creating Low Carbon Society (LCS) is one of the many projects aimed at reducing GHG emission without compromising economic and social development, which is important to developing countries like Malaysia. Aiming at informing the Gleneagles Dialogue on Climate Change, Clean Energy and Sustainable Development established during the 31st G8 summit (in UK's 2005 presidency), the Japan-UK Low Carbon Society project was started. In the first workshop of this project, the working definition of a low carbon society was established. A low-carbon society should:

(i) take actions that are compatible with the principles of sustainable development, ensuring that the development needs of all groups within society are met
(ii) make an equitable contribution towards the global effort to stabilize the atmospheric concentration of CO_2 and other GHG at a level that will avoid dangerous climate change, through deep cuts in global emissions
(iii) demonstrate a high level of energy efficiency and use low-carbon energy sources and production technologies
(iv) adopt patterns of consumption and behaviour that are consistent with low levels of greenhouse gas emissions.

The definition also emphasizes the importance of technology in realizing the vision of LCS, in addition to the need of lifestyle and social change among the members of the society (Skea & Nishioka, 2008). A LCS comprises of economic growth and social development that are aligned with sustainable development, residents who are aware of the need of sustainable development, adopt behaviour that are consistent with reducing GHG emission, aware of choices of renewable energy and conscious about energy efficiency.

Iskandar Malaysia

South Johor Economic Region (SJER), or known as Iskandar Malaysia (IM) is located at the southern part of Peninsular Malaysia. It covers the entire district of Johor Bahru and several sub-districts of Pontian with an area of approximately 2217 km^2. IM is to be developed into a strong and sustainable metropolitan area of international status (Khazanah National, 2006). Ho & Fong (2007) in their study had shown the possibility of developing IM as a low carbon city. In order to reduce the carbon emission by 2025, it was proposed that aggressive energy saving measurements should be drawn and policies implemented. Although education is listed as a part of the policy package proposed in the development Iskandar Malaysia into a Low Carbon City (Ho *et al.*, 2009), there are no further elaborations on the education approach. Education is only viewed as increase knowledge on Green Labeling and Eco labels. As environmental education is a means to increase the awareness and promote attitude and behavioural change towards

the environment, it is vital to include education in promoting Low Carbon Society in the long term.

Environmental Education (EE)

In 1972, education was identified as an important way to address environmental issues in the United Nation Conference on the Human Environment held in Stockholm (Sterling, 2004) and once again stressed in Agenda 21, the agreement reached at the Earth Summit, held in Rio de Janerio in 1992 (United Nations, 1992). The major goals of EE are to create awareness and concern about the environmental issues, where individuals are sensitive to the changes of the environment (and changes that are to be brought about by their actions), and to provide each individual the opportunity to acquire the knowledge, attitude, skills and commitment to protect and improve the environment (Stapp *et al*., 1969; IUCN, 1970; UNESCO-UNEP, 1976; Bossanyi, 1977; Kelly, 1977; Jackson, 1978; UNESCO-UNEP, 1978).

During the 3rd workshop for and symposium of the Japan-UK Joint Research Project on Low Carbon Society, one of the key areas discussed was behaviour change and its impact on delivering LCS. Negative public attitude is the major barrier to personal lifestyle change where public is confused, unknowledgeable about climate change and they feel powerless of what they can do to make a difference (NIES, 2008). It was concluded that consumers as individuals possess the power to drive emission reductions but they need information about the choices they have. Education and awareness have to be promoted through government leadership and policies to enable public to make low-carbon purchasing decision and adopt good practice of low-carbon lifestyle.

In the International Working Meeting on Environmental Education in the School Curriculum (IUCN, 1970), environmental education should be incorporated in all school subjects. Similarly, in the Belgrade Charter (UNESCO-UNEP, 1976) and Tbilisi Report (UNESCO-UNEP, 1978), it was stated that environmental education is interdisciplinary in nature, cutting across various subjects. As such it would be best to be integrated into existing curriculum, and not to be a stand-alone subject. Other scholars (Carson, 1977; Kelly, 1977; Berry, 1978; Jackson, 1978) also advocate the integration of environmental elements or components into the existing curriculum to reflect its interdisciplinary nature, without changing the entire sturcture of the curriculum.

The Malaysian Physics curriculum for secondary schools aims at preparing students with adequate knowledge and skills, together with good attitude and moral values to make decision and solve problems in their future studies and/ or work, by developing students' scientific thinking skills which will enable them to evaluate science and technology information critically (Curriculum Development Centre, 2007). This will lead them to be aware of the balance between development and environment preservation and conservation. Physics is one of the four elective science subjects offered at upper secondary level (Form Four and Five). The curriculum consists of an introduction to Physics and nine learning areas (or chapters), they are: Forces and Motion, Forces and Pressure, Heat, Light, Waves, Electricity, Electromagnetism, Electronics and Radioactivity. Energy and environmental issues are interrelated. The production and consumption of energy is at the core of LCS concept because energy efficiency and the choice of electricity generation were among the most important contributors to the reduction of CO_2 emission (Skea & Nishioka, 2008). It can be concluded that Physics plays an important role in promoting LCS concepts in formal curriculum.

EE in Malaysia started its move when Malaysia's Education Planning Committee, Ministry of Education then decided to integrate EE throughout the New Primary School

Curriculum and the Integrated Curriculum for Secondary Schools in 1991 (Thiagarajan & Nor Shidawati, 2005; Daniel *et al.* 2006). However, the development of EE in Malaysia is still in progress. Daniel *et al.* (2006) summarized from literature gathered that Malaysians (students and the general public) generally possess good factual knowledge of environmental problems but moderate level of understanding about environmental issues. Despite of the moderate to good knowledge, understanding and positive attitude, Malaysians demonstrate low level of positive environmental actions (pro-environmental behavior). As Low Carbon Society (LCS) is a relatively new concept developed recently, there were no studies and plan of education intervention in LCS project. With the goal of environmental education in mind, the introduction of LCS concepts in formal education (Physics) would be one of the steps to be taken to achieve the goals of EE as a whole.

The purpose of this study is to understand the level of awareness of upper secondary school students in the area of Iskandar Malaysia taking Physics, about the concepts of Low Carbon Society, the need for it and to propose learning material relating to it into school Physics curriculum, especially for the five districts involved in IM. This research aims to answer the questions (1) What are the elements in the Low Carbon Society concept? (2) What is the current level of awareness of upper secondary school students taking Physics about Low Carbon Society lifestyle? (3) What is/ are the learning area(s) in the current Physics syllabus which is related to the concept of Low Carbon Society? and (4) What additional information is needed in the current Physics syllabus to promote student awareness of the concept of Low Carbon Society?

METHODS

This is a descriptive study where it aims to describe the current situation of students' awareness level on Low Carbon Society concepts. Based on the components of Low Carbon Society identified, a survey was conducted. This study also includes content analysis of the current Physics syllabus and textbooks, aiming to describe the components of Low Carbon society in the content of these documents.

Sample

There is a total number of 6837 Form Four students from the four districts Johor Bahru, Kulai, Pasir Gudang and Pontian (information from ICT Unit, *Jabatan Pelajaran Negeri Johor* as at year 2011). According to Krecjie & Morgan (1970), the minimum sample size should be 364 students for the above population size. 503 students were selected using cluster random sampling because it is more feasible to implement in schools where is often difficult or almost impossible to select individual random sample from schools (Fraenkel & Wallen, 1993). As such, seven schools were selected using stratified random sampling according to proportion of the student numbers in the district. The current KBSM Physics syllabus and textbooks for both Form Four and Five will be used for the content analysis.

Research Instrument

A subject-completed (or self administered) questionnaire was used in the survey. There are several instruments measuring environmental awareness and concern being used in previous studies such as measurement of environmental concern developed by Maloney & Ward (1973), Environmental Concern Scale, ECS developed by Wiegel & Wiegel (1978), Environmental Attitude Scales by Arbuthnot (1977) and the New Environmental Paradigm scale (NEP) by Dunlap & Van Liere (1978) (all summarized in Chan, 1996). In more recent studies, the Middle School Environmental Literacy Instrument (MSELI) used in a national survey conducted by McBeth & Volk (2010) to

measure United States' national environmental literacy and at home, instruments used in a national-scale study by Tamby Subahan *et al.* (2010) measuring environmental knowledge, attitude, skills and participants of primary and secondary school students. However, all these instruments are used to measure general environmental knowledge, attitude and concerns.

As there is no existing instrument measuring carbon-specific information, an instrument was developed with reference to the four of the six objectives outlined in the Belgrade Charter (UNESCO-UNEP, 1976). The questionnaire was in bi-language, English and Bahasa Malaysia. 15 multiple-choice questions were used to measure the level of awareness and knowledge of the LCS concepts while 17 statements related to LCS with a five-point Likert scale were used to measure the students' degree of agreement. Items were adapted from Wiegel & Wiegel's Environmental Concern Scale (1978) modified to be more carbon specific. Students' participation level was investigated using 19 low carbon daily activities with a five-point verbal frequency scale. For the analysis of syllabus and textbook, key components identified from the analysis of Low Carbon Society literature were used to identify learning area(s) in the syllabus and textbooks which are related to the elements.

The questionnaire along with a list of identified LCS components was reviewed by Professor Ho Chin Siong, of Faculty of Built Environment, Universiti Teknologi Malaysia for content validation. He has been working on the Low Carbon Society study using Asian Pacific Integrated Model (AIM) developed by National Institute of Environmental Studies (NIES) with Kyoto University (National Institute of Environmental Studies, 2008). He was involved in exploring scenarios and possibilities of developing Iskandar Malaysia into Low Carbon city, and has proposed several strategies to achieve that (Ho & Fong, 2007; Ho *et al.*, 2009). A pilot study was conducted using 67 students (from two classes of Form Four students) in Pasir Gudang district. The instrument obtained a Cronbach alpha coefficient of 0.7271. The format of the instrument was also tested including terms or vocabulary used and sentence structures to avoid misunderstanding or mis-interpretation of the items.

RESULTS AND DISCUSSION

COMPONENTS OF LOW CARBON SOCIETY (LCS)

From the working definition of Low Carbon Society, four main components were identified. The components are

(i) The principles of sustainable development
(ii) Contribution towards reduction of CO_2 emission
(iii) Choose high energy efficiency devices and use low-carbon energy sources and production technologies
(iv) Choose lifestyle and exhibit behaviour that emit low greenhouse gases

Other than the above components, an additional component on the background knowledge of climate issues (focusing on greenhouse phenomena, its cause and effect) was added to construct the items used in the survey.

QUESTIONNAIRE SURVEY

Demographics

A total number of 503 questionnaires were distributed and 466 of them were returned and analysed. The demography of the samples is shown in Table 1.

Table 1 : Demography of samples

Item	Frequency	Percentage (%)	Item	Frequency	Percentage (%)
Gender			Family Income		
Male	229	49.8	<RM1000	149	34.0
Female	231	50.2	RM1001-RM2000	121	27.6
			RM2001-RM3000	69	15.8
Race			RM3001-RM4000	34	7.8
Malay	227	49.5	RM4001-RM5000	22	5.0
Chinese	179	39.0	>RM5001	43	9.8
Indian	47	10.2			
Others	6	1.3	School Location		
			Urban	394	84.5
			Rural	72	15.5

* Cases might not total up to 466 as there are missing items.

Level of Awareness and Knowledge about the concepts of Low Carbon Society

The mean and the standard deviation for total score for knowledge is 4.36 and 1.95 respectively. The mean (31.2% in a 100-point scale) showed a fairly low performance among the students in this section. Although the result coincides with the study conducted by Tamby Subahan *et al.* (2010), most of the previous studies (Chapman & Sharma, 2001; Aini *et al.*, 2003; Sharifah *et al.*, 2005; Daniel *et al.,* 2006; McBeth & Volk, 2010) found that respondents had scored fairly high in the aspect of environmental knowledge. As the items constructed for this study is relatively specific to the concept on LCS in oppose to most of the existing studies which covers general environmental issues, students might have a good general knowledge about most of the environmental issues but lack the grasp of detail in specific knowledge such as those measured in the LCS instrument. Table 2 zooms-in to the correct and incorrect percentage for each item.

Table 2 : Frequency table for each item in the Section A

Item No	Item component	Correct (%)	Incorrect (%)
1	Carbon cycle	30.9	69.1
2	Climate change and global warming	33.3	66.7
3	Greenhouse effect	15.0	85.0
4	Causes of issues – greenhouse gases	12.0	88.0
5	Effects of issues	24.0	76.0
6	Carrying capacity	13.9	86.1
7	Sustainable Development – interdependence	45.1	54.9
8	Sustainable Development – interdependence	38.2	61.8
9	Contribution to reduction of CO2 emission	23.8	76.2
10	Energy efficiency	55.4	44.6
11	Energy efficiency	44.4	55.6
12	Renewable energy	25.8	74.2
13	Consumption & lifestyle	22.5	77.5
14	Role of policies/ government	51.9	48.1

More than half of the students scored incorrectly in all items except Item 10 and 14. Students scored poorly in the background knowledge of climate issues related to low carbon society such as the greenhouse effect, the causes of greenhouse effect and the carrying capacity of the universe. As the sample consists of Form Four students, they were probably not exposed academically to the scientific ideas of these issues at the time when the study was conducted. The subject related to these issues is Biology, and is organised in the Form Four syllabus as the last theme of study. The result reflects a fairly good understanding of the concepts of energy efficiency among the students. This is mainly because of the topic discussing about energy efficiency is in the Form Four Physics syllabus, and was taught early of the semester (Curriculum Development Centre, 2007). However, they did not perform as good in the item related to renewable energy because this topic is organised to be in the Form Five Physics syllabus. Students will not be exposed to it academically until the following year. It could be hypothesised that students gain awareness and knowledge from topics or subjects in the formal academic education (formal curriculum). However, a comparison study needs to be conducted between Form Four and Five students to confirm this argument.

Attitude towards the concepts of Low Carbon Society

The mean and standard deviation of the total score in the Attitude section is 56.34 and 7.28 respectively. The students' overall attitude towards the components that make up the concepts of LCS is moderately high (63.03 in a scale of 100-points). This is in line with previous studies among student teachers (teacher trainees) (Mohamad Termizi & Zurida, 2009) and middle or secondary school students (Chan, 1996; McBeth & Volk, 2010) where it was found that they have moderate level of positive attitude towards environmental issues. Table 3 gives the frequency distribution of each item in this section.

All items show positive attitude towards the concepts of LCS except item 16. 41.1% of the respondents neither agreed nor disagreed with the statement. Slightly more than one third (36.8%) of the respondents agree that the problem of excessive carbon emission is unlikely to happen because the government is taking steps to control it. Perhaps most of the students do not have the information about what control measures are in place and how it works.

A quarter of the students disagree to the choice of high energy efficiency appliances and also a quarter of them see no problem with energy sources in our country. The students might not regard energy source as a form of natural resource, as there is no explicit information in their current textbooks. Similarly, there is a lacking of practical application of energy efficiency knowledge in their daily lives (such as factors to consider when choosing electrical appliances). It is also interesting to note that in item 14, about one third of the respondents (33.9%) would still prefer to use personal vehicle to go to school even if public transportation was more efficient than it is.

Table 3 : Frequency distribution of LCS attitudes of respondents

Item No	Item	SD (%)	D (%)	N (%)	A (%)	SA (%)	Mean	Std Dev	
1	We should not worry too much about emitting too much carbon dioxide because in the long run, things will balance out naturally.	49.8	32.3	10.8	4.5	2.6	4.22	0.99	*
2	Although there is continual increase in temperature, nature's processes will soon return them to the normal.	30.6	29.3	24.8	12.7	2.6	3.73	1.11	*
3	Industries should be accountable for emitting the most carbon to the atmosphere.	6.3	6.0	11.0	31.0	45.7	4.04	1.17	
4	Climate change is not personally affecting me.	34.8	32.4	19.2	9.9	3.7	3.85	1.12	*
5	There are always enough resources on Earth for human use.	24.8	30.4	21.3	16.3	7.2	3.49	1.23	*
6	Natural resources must be utilized to maintain economic growth for meeting human needs.	4.8	9.3	23.5	29.8	32.6	3.76	1.14	
7	We cannot do very much in the reduction of CO_2 emission because we are only a small population compare to the whole population of the world.	20.0	28.0	30.0	14.2	7.8	3.38	1.18	*
8	I would choose to use energy efficient appliances even if it is more expensive.	7.6	15.2	26.7	34.1	16.5	3.37	1.15	
9	There should not be too much problem with energy sources because there are abundant resources in our country.	17.7	27.3	26.2	24.5	4.3	3.30	1.15	*
10	I would be willing to make personal sacrifices for the sake of slowing down global warming even though the immediate result may not seem significant.	5.4	10.4	27.9	41.1	15.2	3.50	1.04	
11	If asked, I would contribute time or money to an organization that works to improve the quality of the environment.	3.3	6.8	21.8	44.4	23.7	3.79	0.99	
12	The benefits of modern consumer products are more important than the carbon emission that results from their production and use.	19.4	21.8	30.6	18.8	9.4	3.23	1.23	*
13	We must prevent any type of carbon emission even if it means sacrificing some things for ourselves.	4.6	9.1	21.3	44.7	20.4	3.67	1.04	
14	Even if public transportation was more efficient than it is, I would prefer to use personal vehicle to go to school.	15.7	27.6	22.8	23.9	10.0	3.15	1.23	*
15	Industry is trying its best to develop effective low carbon technology.	5.4	10.4	27.7	36.6	19.9	3.55	1.09	
16	Because the government has such good inspection and control agencies, it's very unlikely that carbon emission due to energy production will become excessive	7.8	14.3	41.1	24.7	12.1	2.81	1.07	*

* On a 1-5 scale, mean scores for items 1, 2, 4, 5, 7, 9, 12, 14 and 16 were reversed so that high scores represent positive environmental (low carbon) attitudes

Participation in activities related to the concepts of Low Carbon Society

The result from this section reflects their current practices and throws us some light to what low carbon related activities they actually engage in, in their daily lives. The mean score for Participation is 67.43 while the standard deviation is 10.47. It shows that the students scored fairly high in a scale ranging from 19 to 95. Table 4 shows the frequency distribution of each item in this section. Respondents showed positive

participation in Low Carbon activities or exhibit habits that are consistent with Low Carbon concept in most of the items.

Table 4 : Frequency distribution of LCS participation of respondents

Item No	Item	Never (%)	Seldom (%)	Some-times (%)	Most of the time (%)	Always (%)	Mean	Std Dev	
1	Separating waste according to their category (recyclable and non-recyclable items)	13.6	27.4	30.2	13.6	15.3	2.90	1.25	
2	Selling or donating old things which can be recycled/ reusable.	4.1	10.4	26.7	29.7	29.1	3.69	1.12	
3	Switch off electrical appliances when I do not use them.	2.4	2.0	9.8	21.5	64.4	4.44	0.92	
4	Switch off lights before going to sleep.	3.1	3.5	7.2	10.7	75.6	4.52	0.99	
5	Let water running while brushing teeth.	41.6	22.2	15.0	11.1	10.0	3.74	1.36	*
6	Collect plastic bags for other usage (to be used as garbage bag).	3.3	7.4	11.8	18.7	58.8	4.22	1.12	
7	Bring own bag when shopping.	28.0	24.8	22.4	10.2	14.6	2.58	1.37	
8	Shut down or put my computer to standby mode (power safe mode) when I am not using it.	8.2	10.0	14.3	23.9	43.6	3.85	1.30	
9	Buy outfits only when the old ones are worn out.	11.4	15.3	32.0	17.8	23.4	3.27	1.29	
10	Use reusable paper to take notes.	6.2	13.8	23.4	25.4	31.2	3.62	1.23	
11	Bring own food to school.	15.8	23.6	28.8	15.2	16.7	2.93	1.30	
12	Eat locally produced food.	3.0	11.0	28.8	26.6	30.5	3.71	1.11	
13	Choose high energy efficiency electrical appliances.	7.5	13.6	33.4	25.4	20.0	3.37	1.17	
14	Use public transport/ cycle/ walk to school	12.3	17.3	15.6	14.1	40.7	3.53	1.47	
15	Switch on air-conditioning whenever I feel hot.	27.2	21.6	22.0	17.3	11.9	3.35	1.35	*
16	Utilize sunlight compare to electrical lighting during daytime.	6.9	8.8	17.2	18.1	48.9	3.93	1.28	
17	Alert to environmental information announced by the government.	5.8	11.9	31.1	28.9	22.2	3.50	1.13	
18	Alert to environmental related news reported by the media.	3.0	11.4	27.8	33.6	24.1	3.64	1.06	
19	Participate in environmental programme(s).	11.6	20.0	31.8	20.9	15.7	3.09	1.22	

* On a 1-5 scale, mean scores for items 5 and 15 were reversed so that high scores represent positive environmental (low carbon) participation

The mean score for items 1, 7 and 11 were fairly low. Majority of the students (Item 1, 41.0%) do not have the habit of separating waste (recyclable and non-recyclable). But at the same time, the result shows that more than half of them sell or donate recyclable or reusable things. This is as puzzling as it is interesting. Perhaps the students perceive waste as things to be disposed, which has no value and cannot be sold or donated. In order to explain this situation, further interviews would be needed to clarify students' perception of "recyclable waste" and "non-recyclable waste". The mean score for Item 7 (2.58) is particularly low compared to other items. A closer look at the frequency distribution reveals that only a quarter of the respondents (24.8%) habitually bring their own bags when shopping. Despite of the recent movement in encouraging the

members of society to bring their own bags when shopping, more than 50% of the students seldom or never bring theirs when shopping. It is indeed not yet a habit formed.

The students responded very positively (scored very high) in items related to conserving electricity and water in daily activities (Items 3, 4, 5, 8 and 16). More than three quarter of the students have the regular habit of collecting used plastic bags to be used as garbage bag. Although the majority of the students expressed that they are alert to environmental information and related news announced or reported by the media, less than 40% of them participate in environmental programmes. Most of the environmental programmes in schools are on ad hoc basis or taking form of extra-curricular activities. As such, it is important to integrate LCS concepts into the formal curriculum to make it available to most if not all students.

SYLLABUS AND TEXTBOOKS ANALYSIS

All of the learning areas identified are related to the component of energy efficiency and low carbon energy sources (Table 5). A qualitative analysis of both Form Four and Five textbooks reveals that the information in the identified learning areas are presented in the text mainly as factual information (statements of facts and formula of efficiency in the context of input and output energy) work examples (application of formula in solving problems related to energy efficiency) and suggested activities (discussion, observation, classifying and group project by researching and reporting).

As there are no explicit LCS information (behaviour and lifestyle) presented in the text, it is very much depending on the discretion of the teacher to whether discuss these topics in detail or otherwise. Chapman & Sharma (2001) stated that students should be taught not only concepts in classroom but to foster attitude, motivation, commitment and skills to solve contemporary environmental problem such as climate change. However, currently there is no official reference for teacher's usage on how to conduct or evaluate these activities (in the textbooks). As such, it is vital to produce a guidebook which includes more information in low carbon which is related to the topics in the syllabus. This will not only assist the teachers in their teachings and to guide students to apply the skills obtained in the classroom to daily lifestyle, at the same time, it will also raise teachers' awareness and knowledge of low carbon concept, and align their own behaviour and practices towards low carbon.

Table 5 : Learning areas, learning objectives, Learning areas, LCS components and content of text in KBSM Physics textbooks (Form Four and Form Five)

Form/ Learning area/ Learning objective	LCS component	Information presented in the form of	Content of text (Page/ Note)
Form Four 2.0 Forces and Motion 2.10 Understanding work, energy, power and efficiency 2.11 Appreciating the Importance of Maximising the Efficiency of Devices	EE	Fact	64/ Formula of efficiency
	EE	Work example	65/ Calculating efficiency
	EE	Fact	66/ Energy loss (only mentioned consumers are paying for energy)
	SD, EE	Fact	66/ Limited resources and loss of energy create the need to conserve resource
	SD, EE	Activity	67/ Maximising efficiency of devices
Form Five 2.0 Electricity 2.5 Analysing electrical energy and power	EE	Activity	71/ Energy audit of electrical appliances in a house
	EE	Fact	72/ Principle of conservation of energy and wasted energy
	EE	Activity	72/ Classifying useful & wasteful energy
	EE	Figure	72/ EE label used to rate electrical appliances
	EE	Work example	73/ Calculating energy efficiency
	EE	Activity	73/ Comparing 2 light bulbs
	EE	Activity	74/ Saving cost of electricity
	EE	Activity	76/ Increase energy efficiency, importance of maintenance
3.0 Electro-magnetism 3.5 Understanding the generation and transmission of electricity 3.5 Understanding the generation and transmission of electricity (Renewable Energy)	RE	Fact	103/ Power plants in Malaysia & energy sources
	RE	Activity	104/ Various energy sources
	RE	Fact	106/ Renewable energy and sustainable energy
	CO_2, RE	Figure	106/ The origins of fossil fuels
	EE, RE	Activity	107/ Importance of energy efficiency and renewable energy, effects on environment.
	EE	Activity	107/ Designing energy efficient house/ building
5.0 Radioactivity 5.4 Understanding nuclear energy	RE	Fact	166-167/ Advantages and disadvantages of nuclear energy
5.5 Importance of proper management of radioactive substances	EE	Activity	171/ Feasibility of building a nuclear power plant in Malaysia

Legend: EE – LCS component of energy efficiency; RE – LCS component of renewable energy source (Low carbon energy source and production technologies); SD – LCS component of principle of sustainable development; CO_2 – LCS component of carbon dioxide reduction.

CONCLUSION

This study has provided preliminary information on the level of awareness, knowledge, attitude and participation of Low Carbon Society (LCS) among secondary science students. It shows that students have fairly low knowledge level, fairly positive attitude and fairly high participation level in LCS activities. It serves as a baseline data or benchmark for future intervention programmes. It has also provided input on information needed in the syllabus for promoting Low Carbon Society lifestyle.

Students today are policy makers, decision makers and consumers tomorrow. An average of 33% students enrolling in upper secondary school are from Science and Technical stream (Educational Management Information System, 2010). Therefore, by embedding the concepts of low carbon society into the Physics curriculum, we are exposing low-carbon society concepts to one third of the students enrolling to upper secondary school. Introduction of low-carbon society concepts, together with the low-carbon city policies which include mitigation options from the aspects of buildings, transport and land use and industry, will ensure smooth transition of Iskandar Malaysia towards a low-carbon society. This will be in line with Malaysian government's effort in addressing climate change issues.

While this study has been an initial study for measuring level of awareness, knowledge, attitude and participation of Low Carbon Society (LCS), there are several areas need to be addressed in future studies. The instrument used need to be improved further by establishing more than one type of validity and higher reliability. As the textbook analysis have shown, teachers plays an important role in disseminating LCS concepts, it is deemed important to gauge teachers' understanding of LCS concepts, their attitude and participation level. As such, a baseline data of secondary school teachers, particularly those who are teaching science subjects could be established. For the textbook, it is suggested to include climate issues into Physics syllabus particularly in topics related to "energy", and information should not be limited to facts but should include skills, values and behaviour (daily lifestyle) in textbook or teacher's guide. LCS components could be included into other areas of studies such as Biology and Chemistry, as both are branches of the physical science offered as formal subjects in secondary schools.

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