Achieving Low Carbon Society through Primary School Ecolife Challenge in Iskandar Malaysia

Fatin Aliah Phang*,a, Wong Wai Yokeb, Ho Chin Siongc, Aerma Nurazalina Musad

aCentre for Engineering Education, Universiti Teknologi Malaysia (UTM), 81310 UTM Johor Bahru, Johor, Malaysia.
bFaculty of Education, Universiti Teknologi Malaysia (UTM), 81310 UTM Johor Bahru, Johor, Malaysia.
cUTM Low Carbon Asia Research Centre, Universiti Teknologi Malaysia (UTM), 81310 UTM Johor Bahru, Johor, Malaysia.
dJabatan Pendidikan Negeri Johor, Jalan Tun Razak, 80604 Johor Bahru, Johor, Malaysia.
p-fatin@utm.my

Iskandar Malaysia Ecolife Challenge was initiated jointly between Universiti Teknologi Malaysia (UTM) and Iskandar Regional Development Agency (IRDA) in 2013 with the collaboration and full support from the Johor State Education Department (JPNJ). It started with 23 pilot primary schools to complete a workbook designed by UTM to learn about low carbon society as a post-UPSR activity among Year 6 students. In 2015, all 226 primary schools in the Iskandar Malaysia region were involved in the program. This paper reports how the program has helped to reduce carbon emission in this region and changed the behavior of the students as well as the teachers. Questionnaire measuring the students' low carbon practice at home was distributed every year before the beginning and at the end of the program. Data on the household electricity and water usage, mileage of the vehicle and number of household members were captured. From the analysis of 1,496 completed workbooks submitted, the average number of one household is 5.42 or 5 to 6 persons in a house. The average electricity usage of a household in a month is 478.22 kWh or equivalent to emission of 325.19 $kgCO^2$, while the average water usage of a household in a month is 39.28 m^3 or equivalent to emission of 16.46 $kgCO^2$. On the use of a household vehicle, a vehicle travels on average 32.87 km/d and 201.77 km/week. In term of the low carbon practice among the students, after accounting for the household carbon emission using the workbook, the practice on low carbon increase from 2.42 to 3.04 on a 5-point scale. This provides rich data on the carbon emission pattern of a household in Iskandar Malaysia and that the program has helped to improve the students' practice and awareness on low carbon society.

1. Introduction

According to the "Low Carbon Society Blueprint for Iskandar Malaysia 2025", Iskandar Malaysia, a southern development region in Malaysia, aims at reducing 18.9 $MtCO_2$ equivalent in 2025 (UTM-Low Carbon Asia Research Centre, 2013). This is 50 % carbon reduction target for Iskandar Malaysia (Ali et al., 2013). To achieve this big target, the blueprint has proposed 12 actions for Iskandar Malaysia. In Action 6, namely "Low Carbon Lifestyle", a sub-action named "Awareness through Education" has drawn two measures which are to enhance the public and school children awareness. One of the programs to achieve the measure to enhance school children awareness is through Ecolife Challenge (UTM-Low Carbon Asia Research Centre, 2013). This paper discusses how the program was initiated, implemented and how it is relevant in not just to create awareness among school children on low carbon society but also realizes the carbon reduction target.

2. Ecolife Challenge

Ecolife Challenge is an educational program designed by Universiti Teknologi Malaysia (UTM) and Iskandar Regional Development Authority (IRDA) in 2013 to raise low carbon awareness among primary school students and through workbook activities and school project (Phang et al., 2016a). A similar program was initiated by a non-profit organization in Kyoto to create awareness about climate change through a workbook to be completed by students during their summer or winter school holidays (KIKO Network, 2012). UTM proposed the program

to be conducted in a competition format for Iskandar Malaysia (Phang et al., 2016b). In this competition, Year 6 students (aged 12 years old) are given three modules to be completed in one month. The modules are recycling, utility bills saving and workbook. 15 schools with the highest recycling weight collected, highest school utility bills reduction and highest workbook completion and return rate are chosen to enter the final oral presentation where the winner group will be awarded a study trip to Kyoto. Refer to Phang et al. (2016b) for the details of the competition.

The Ecolife Challenge workbook is designed to provide knowledge and raise awareness on Low Carbon Society (LCS) to primary school students through several engaging activities such as providing information on carbon emission using pictures and diagrams, filling in the blanks, drawing, colouring and household accounting to be done with their family members. The workbook is also designed with the purpose to collect information related to carbon emission and low carbon practices at home among the students. The cover page of the workbook collects data on the name of the school and the number of household members of the students. The workbook contains a page to survey the students' low carbon practice before and after the completion of the workbook and other modules. In other sections, the students were asked to count the number of electrical appliances at their home. This was to raise awareness among students' about the relationship between electricity usage at home and their lifestyle. Students were asked to make conclusion from their findings about relationship between the number of electrical appliances and their household electricity usage. Students were also asked to provide their household electricity and water bills the month before the Ecolife Challenge competition (September) and the month after the competition (October). They are asked to calculate the differences in the use of electricity and water as well as translating them into carbon emission. The students are also tasked to track a vehicle at home for one week, recording the mileage of the vehicle every day in the morning. Students were guided by pictures of how to read their household utility bills and odometer for vehicle. All the activities end with a self-reflection section which is related to carbon emission and global warming. This is to create awareness among the students. All the activities in the workbook are designed based on the primary school syllabus to ensure that the students are capable of completing the workbook and can relate what they have learnt at schools with the workbook. This is the first workbook designed to inculcate LCS among primary school students which is aligned to the school curriculum.

3. Low Carbon Activities for Schools in Malaysia

This section of the paper is very important to collect and highlight all the relevant school projects or activities in Malaysia that can be related to achieving low carbon society yet they are not being reported any academic document. The information is gathered through internet search and contact of the relevant personnel. Hence, this section is important to be published as a part of the paper to justify the importance to have this Ecolife Challenge that is designed based on the environmental education framework by Palmer and Neal (2003).

There are not many activities or programs focusing on LCS for school children in Malaysia as it is a relatively new concept in environmental education. Notably the World Wide Fund for Nature (WWF) Malaysia is actively conducting the Eco-Schools program. "Eco-Schools is an international initiative designed to guide schools in implementing a whole-school approach towards environmental and sustainability education. Its holistic, participatory approach and combination of learning and action make it an ideal way for schools to embark on a meaningful path for improving the environments of schools and their local communities. Currently, the programme is being implemented in over 50 countries around the world, involving more than 40,000 schools. Its adoption in Malaysia offers the promise of consolidating various environmental education efforts that are already in place in schools" (WWF Malaysia, 2016). Currently, there are 54 primary schools in the whole Malaysia that join the program. Though LCS may not be the focus of the schools, several themes of the program are highly related to LCS namely Water, Waste/litter, Energy, Nature and biodiversity, School grounds, Transport/Sustainable mobility, Healthy Living, Local Agenda 21 and Climate Change based on the working definition of LCS (NIES, 2006).

Another low carbon school program is the Green School Campaign initiated by PenjanaBebas, the Association of Independent Power Producers in Malaysia in collaboration with the Ministry of Energy, Green Technology and Water (KeTTHA) to install solar panel at selected schools in Malaysia since 2010. "The PenjanaBebas-KeTTHA Green Schools Campaign (GSC) is a public-private partnership CSR programme that brings renewable energy into Malaysian schools. The GSC empowers schools nationwide via the installation of photovoltaic (PV) panels as well as the roll-out of awareness programmes. The initiative provides a platform for Malaysian students to gain exposure and learn first-hand about the practical applications of renewable energy" (Green School Campaign, 2016). The total electrical energy generated is translated into carbon emission avoided in the website as a form of reporting from the schools. Currently, there are 138 schools in Malaysia participating the program.

Sustainable School or Sekolah Lestari is also a school program that can be related to LCS indirectly. It is established in 2005 by the Ministry of Natural Resources and Environment, Ministry of Education and Universiti Kebangsaan Malaysia, UKM (NRE, 2016). Participating schools submit a report and are audited for their effort in making the schools sustainable based on four components – school management, greening, co-curriculum and curriculum. The schools can initiate any projects, activities or programs at schools or outside of the schools. Their efforts are awarded Sustainable School Award every year. About 10 % - 20 % of schools from each state applied and granted the Sustainable School.

All these activities are not directly targeting at introducing LCS alone although some of them may be carrying out activities that can reduce carbon emission. Therefore, a concentrated and direct effort must be taken to introduce LCS, especially in the region of Iskandar Malaysia in order to realize the carbon reduction aim outlined in the blueprint.

4. Data Collection Method

The aim of this research is to identify if carbon reduction can be achieved through Ecolife Challenge by collecting various data using the workbook. The data includes the number of household members, the students' low carbon practice before and after the competition, the utility bills before and after the competition and the mileage of a vehicle at home. In 2015, a total of 27,628 Year 6 students from all 226 primary schools in the region in Iskandar Malaysia participated in this competition. However, due to the poor management of the new organizer of this competition in 2015, only 10,272 (37.2 %) copies of workbooks were submitted. After a round of preliminary checking, it was found that only 3,173 workbooks were completed. After marking and sorting out the outliers, 1,496 workbooks were processed for data analysis.

5. Data Analysis and Discussion

Table 1 shows the mean values of the data collected. A household has about 5 to 6 members. According to the latest Population and Housing Census of Malaysia' Preliminary Count Report 2010 (Department of Statistics, Malaysia, 2010), the average household members in Malaysia is 4.31, where Johor has 4.17. With the declining trend of number of household members or household size for Malaysia since 1980, the number of household members for Iskandar Malaysia is considered to be quite high. Sabah has household size of 5.88, which is the highest in Malaysia in 2010. This may indicate that Iskandar Malaysia is a growing and developing region and the targeted population of 3 million can be achieved by 2025.

Table 1: Mean value of data collected from Ecolife Challenge workbook

Variable	Mean value
Number of household members	5.42
Low carbon practice before Ecolife Challenge (5-point scale)	2.42
Low carbon practice after Ecolife Challenge (5-point scale)	3.04
Electricity usage before Ecolife Challenge (September)	478.22 kWh
Electricity usage after Ecolife Challenge (October)	382.21 kWh
Water usage before Ecolife Challenge (September)	39.28 m^3
Water usage after Ecolife Challenge (October)	32.81 m^3
Number of vehicles owned by a household	4.66
Mileage per vehicle per day	32.87 km
Mileage per vehicle per week	201.77 km

There is an increase of 12.4 % in the low carbon practice before (mean value 2.42) and after (mean value 3.04) the competition. This is higher than 2014 (Phang et al., 2016b) which was 8.2 % and 2013 (Phang et al., 2016a) which was 7.4 %. Ecolife Challenge shows gradual improvement each year in terms of the percentage of increment in student' awareness and practice in LCS since its introduction in 2013. Interestingly, all of them have the similar starting mean value of practice before the competition which are: 2.44 (2013); 2.49 (2014); 2.42 (2015). This indicates that the survey instrument is reliable over different cohorts of Year 6 students in Iskandar Malaysia. It also indicates that Ecolife Challenge is capable to increase their awareness and practice in LCS.

There is a significant drop in the electricity usage after the competition which is 96.01 kWh. Through this competition, on average, 65.29 kgCO$_2$ can be reduced per household per month (according to KeTTHA (2011), 1 kWh = 0.68 kgCO$_2$). If this pattern is projected to all the household in Iskandar Malaysia in year 2025 which are 750,000 households (Ho et al., 2013), 48.97 ktCO$_2$ emission can be reduced per year from the use of electricity by the residential sector alone.

This pattern can also be seen in the water usage which dropped 6.47 m^3 on average in the month after the competition. Based on the calculation of KeTTHA (2011), 1 m^3 = 0.419 $kgCO_2$, after the competition, 2.71 $kgCO_2$ emission is reduced per household per month. If this is projected to all the 750,000 households in Iskandar Malaysia in 2025, 2.03 $ktCO_2$ emission can be reduced from the water usage. The increase of awareness and practice in LCS and significant decrease in utility bills are positive indicators that Ecolife Challenge can be an effective program to help achieve the LCS blueprint.

In transportation, a household has an average of 4 to 5 vehicles that consume fuel. A vehicle in a household on average travels 32.87 km/d. According to KeTTHA (2011), a car using petrol generates 0.162 $kgCO_2$/km, a car using diesel generates 0.169 $kgCO_2$/km while a car using NGV generates 0.130 $kgCO_2$/km. Therefore, for the sake of this calculation, on average, a vehicle emits 0.154 $kgCO_2$/km. A vehicle in a household emits 5.05 $kgCO_2$/d. If a household has 4 vehicles, it is estimated that each household contributes 7,347.50 $kgCO_2$/y. In 2025, there will be 750,000 households. This means that 5,530.87 $ktCO_2$ will be emitted by vehicles from the residential sector.

Based on the data collected before Ecolife Challenge program using the September electricity bills (478.22 kWh = 325.19 $kgCO_2$), water bills (39.28 m^3 = 16.46 $kgCO_2$) and mileage record (32.87 km (30 d for 4 vehicles per household) = 606.00 $kgCO_2$), on average, a household emits 947.65 $kgCO_2$ per month or 11.37 tCO_2/y. According to Ho et al. (2013), in 2005, with household number of 318,000, the demand of energy for residential sector is 249 ktoe or 1,436 $ktCO_2$. In year 2025, if development continues with "business as usual" where no changes were made to the current lifestyle, 3,407 $ktCO_2$ will be emitted from the energy demand in residential sector. However Ho et al. (2013) projected that if LCS blueprint is implemented, the carbon emission for the use of energy will decrease to about 2,067 $ktCO_2$. Following the data collected from this study, in 2025, 8,528 $ktCO_2$ will be emitted if lifestyle remains "business as usual" from the residential sector.

If the water and electricity consumption pattern that of after Ecolife Challenge program is continued, and the distance travelled by using fossil fuelled vehicle can be halved by walking, cycling and using public transport by 2025, it is estimated that a total of 5,189.85 $ktCO_2$ will be emitted from the residential sector. This figure is four times more than the projected LCS scenario by Ho et al. (2013). Therefore, more efforts must be taken not only from the change of behaviour through awareness and education but other supporting factors such as use of renewable energy, use of technology to improve the efficiency of energy use and switch to other sources of energy that emit little or no carbon (Ho et al., 2013). Initiatives like that of Green School Campaign (2016) to install solar panels at schools providing first-hand experience to students on alternative energy source should go hand in hand with Ecolife Challenge to increase the awareness, knowledge and practice in LCS.

6. Limitations

Although the electricity and water usage were from first hand source (actual utility bills from each student's household), there are limitation to the estimations made regarding the carbon emission. The carbon calculation in this is based on the reference given by KeTTHA (2012) which may not be used by other references in their calculation of carbon emission.

Moreover, the mileage and the number of vehicles per household are records reported by Year 6 students. They are taught by their teachers to read the odometers and pictures of both digital and analogue odometers were supplied in the workbooks for their references. Their teachers went through a training given by researchers from UTM before the workbooks were distributed to the schools. The reliability and accuracy of the data are taken care of (through teachers' monitoring) but there is no guarantee if the students made mistakes in their reading or recording.

From a pool of 27,628 Year 6 students from all 226 primary schools in Iskandar Malaysia, only 1,496 workbooks were analyzed due to the missing data and ambiguous data patterns shown in the completed workbooks. The ambiguous data patterns include the same utility bills were used for a whole class of students, unusual pattern of vehicle mileage such as 3,000 km/d (round trip from home to work) and same rating were given to all the items in the survey. These outliers were excluded from the analysis. Thus, it only represents 5.4 % of the total population. This is a very small sample to represent to whole Iskandar Malaysia.

7. Future Work

There is abundance of data that need to be processed using various methods such as to study the correlation between the number of household members with the carbon reduction (Buchs and Schnepf, 2013), the details of survey results (Phang et al., 2016b), comparison of the use of energy with other cities in the same region and other regions, etc. For example, the electricity usage of residents in Iskandar Malaysia is relative low compared to San Francisco (the lowest electricity usage in the US) which is 7.03 MWh/y per household (Glaeser and Kahn, 2010) based on the calculation that a household in San Francisco uses 585.83 kWh per household. However,

a report by BERNAMA in 2009 that a Malaysia household uses 251 kWh/month (Ali Imran, 2012). This shows that Iskandar Malaysia's residents use more electricity a month compared to the national average. More extensive literature review must be carried out to further make the comparison and conclusion.

The Ecolife Challenge workbook serves as an important tool to gather information and data of the current household energy usage. Therefore, research to improve the workbooks must be taken to ensure that Ecolife Challenge is not only effective in achieving LCS in a long run but also serves as an assessment tool for policy makers to learn how carbon emission can be reduced in the residential sectors and how school students can play an essential role in this.

Data collected from the other modules of Ecolife Challenge, namely the recycling module and the school utility bills are also relevant for analysis and further interpretation about the role of schools in realizing LCS for Iskandar Malaysia. This had been demonstrated in Ecolife Challenge in 2014 (Phang et al., 2016b). A comparison of both 2014 and 2015's data will be conducted.

8. Conclusions

Activities in Ecolife Challenge workbook required not only the students but also parents' involvement, such as obtaining utilities bills and recording household vehicle mileage. This indirectly disseminate information about low carbon practices to the students' family members. This is supported by Phang et al. (2016a) that students reported discussing significantly more about environmental issues with their parents after Ecolife Challenge program. This is further proven through the utility bills collected after the competition. Ecolife Challenge must continue to be improved by focusing on other components of LCS such as transportation and planting. The workbook must encourage the students and their family members to use other means of transportation that consume less or little fossil fuel and use more of the public transports. The workbook should also collect data on the plants that are planted at the students' houses as a means to collect more data of carbon absorption contributed by the residential sector.

The LCS blueprint (UTM-Low Carbon Asia Research Centre, 2013) projected that Action 6 can reduce 2,727 $ktCO_2$ eq if all the programs are implemented. As of now, if Ecolife Challenge is implemented, 51.00 $ktCO_2$ emission can be reduced from the saving of electricity and water usage. There are 23 programs in Action 6. Therefore, the targeted carbon reduction in the blueprint is realistic and achievable if the programs are implemented seriously.

Acknowledgement

Reference

Ali G., Abbas S., Qameer F.M., 2013, How effectively low carbon society development models contribute to climate change mitigation and adaptation action plans in Asia, Renewable and Sustainable Energy Reviews 29, 632-638.

Mohd Noordin A.I., 2012, Cooling Appliances Uncool for Environment, BERNAMA <www.bernama.com/bernama/v3/printable.php?id=676828> accessed 12.07.2016.

Buchs M., Schnepf S.V., 2013, Who emits most? Associations between socio-economic factors and UK households' home energy, transport, indirect and total CO2 emissions, Ecological Economics 90, 114-123.

Department of Statistics, Malaysia, 2010, Preliminary Count Report, Population and Housing Census of Malaysia, Malaysia.

Glaeser E.L., Kahn M.E., 2010, The greenness of cities: Carbon dioxide emissions and urban development, Journal of Urban Economics 67 (3), 404-418

Green School Campaign, 2016, Green School Campaign <greenschools.com.my> accessed 11.07.2016

Ho C.S., Matsuoka Y., Chau L.W., The B.T., Simson J.J., Gomi K., 2013, Blueprint for the development of low carbon society scenarios for Asian regions- case study of Iskandar Malaysia, IOP Conference Series: Earth and Environmental Science 16 (1), 012125

KeTTHA (Ministry of Energy, Green Technology and Water, Malaysia), 2011, Low Carbon Cities Framework and Assessment System, KeTTHA, Putrajaya, Malaysia

NIES (National Institute for Environmental Studies, Japan), 2006, Developing Visions for a Low-Carbon Society (LCS) through Sustainable Development: Executive Summary, First Workshop of Japan-UK Joint Research Project, 14-16 June, NIES, Tokyo, 1-8

420

NRE (Ministry of Natural Resources and Environment), 2016, Sustainable School Award < www.doe.gov.my/ portalv1/info-umum/sekolah-lestari-anugerah-alam-sekitar/163> accessed 11.07.2016 (in Malay)

Palmer N., Neal J., 2003, The handbook of environmental education, Taylor and Francis, Abingdon, United Kingdom

Phang F.A., Wong W.Y., Ho C.S., Fujino J., Musa A.N., Safri I.E., Suda M., 2016a, Low carbon awareness among primary school students through Iskandar Malaysia ecolife challenge competition, Man in India, 96(1), 387-395

Phang F.A., Wong W.Y., Ho C.S., Fujino J., Musa A.N., Suda M., 2016b, Iskandar Malaysia Ecolife Challenge: Low carbon education for teachers and students, Clean Technologies and Environmental Policy, DOI: 10.1007/s10098-016-1215-y

UTM-Low Carbon Asia Research Centre, 2013, Low Carbon Society Blueprint for Iskandar Malaysia 2025, 2nd ed., UTM-Low Carbon Asia Research Centre, Johor, Malaysia

WWF Malaysia, 2016, Eco-Schools Program Malaysia <eco-schools.wwf.org.my/index.cfm?&menuid=45> accessed 11.07.2016