THE EFFECTIVENESS OF PROJECT-BASED ENERGY EDUCATION IN PROMOTING SECONDARY SCHOOL STUDENTS' ENERGY LITERACY

By

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CCE	International Conference on Electrical, Engineering, Computing Science and Automatic Control
CDC	Portal Rasmi Kementerian Pendidikan Malaysia
CETREE	Centre for Educational Training in Renewable Energy and Energy Efficiency
CRES	Greek Centre for the Renewable Energy Sources
CSCP	Collaborating Centre on Sustainable Consumption and Production
EERE	Office of Energy Efficiency and Renewable Energy
EIA	U.S. Energy Information Administration
EPA	U.S. Environmental Protection Agency
ELOB	Expeditionary Learning Outward Bound
IEA	International Energy Agency
KeTTHA	Kementerian Tenaga, Teknologi Hijau dan Air
MOE	Ministry of Education
NAAEE	North American Association for Environmental Education
NCSE	National Centre for Science Education
NRC	National Research Council
NEETF	National Environmental Education and Training Foundation
NGTP	Next-Generation Telematics Protocol
OCEC	Organisation for Economic Co-operation and Development
UNESCO	United Nation Education, Social and Cultural Organisation

KEBERKESANAN PENGAJARAN BERASASKAN PROJEK DALAM MENINGKATKAN LITERASI TENAGA DALAM KALANGAN PELAJAR SEKOLAH MENENGAH

ABSTRAK

Tenaga adalah keperluan asas untuk hidup. Dalam kita bergerak ke masa hadapan mengharungi usaha-usaha globalisasi dengan sumber bahan api fosil yang terhad dan keadaan alam sekitar yang semakin buruk, masyarakat di dunia berhadapan dengan isu menentukan arah baharu berkenaan dengan penggunaan tenaga dan sumber tenaga. Kita memerlukan generasi 'berliterasi tenaga' yang akan dapat membuat pilihan penggunaan tenaga berdasarkan maklumat terkini, dan memupuk sikap, tingkah laku, kepercayaan dan pengetahuan berasas tenaga yang lebih kukuh terutamanya dalam kalangan orang muda. Generasi berliterasi tenaga telah terbukti dapat dihasilkan melalui pendedahan generasi muda terutamanya pelajar-pelajar sekolah menengah kepada pendidikan berasaskan tenaga. Dalam usaha ini pembelajaran berasaskan projek telah direkodkan sebagai satu usaha yang berjaya di negara-negara lain. Sehubungan dengan perkara ini dalam kajian ini usaha telah diambil untuk mengintegrasikan pembelajaran tenaga berasaskan projek sebagai sebahagian daripada aktiviti kokurikulum dan keberkesanan projek ini dalam meningkatkan literasi tenaga dalam kalangan pelajar sekolah menengah telah diukur. Untuk tujuan ini seramai 111 pelajar dari dua buah sekolah menengah telah terlibat dan dikategorikan sebagai kumpulan eksperimen (N = 59) dan kumpulan kawalan (N = 52). Kumpulan eksperimen telah diajar dengan menggunakan pembelajaran tenaga berasaskan projek dan kumpulan kawalan diajar menggunakan kaedah yang lebih

konvensional. Hasil analisis ANCOVA data soal selidik menunjukkan bahawa pembelajaran tenaga berasaskan projek telah meningkatkan tahap literasi tenaga dalam kalangan pelajar dengan amat ketara (pengetahuan [F (1,108) = 79,570, p <0.05; eta = 0,424]; tingkah laku [F (1, 108) = 4,595, p <0.05; eta = 0,041]; sikap [F (1,108) = 5,297, p <9.05; eta = 0,047]; kepercayaan [F (1, 108) = 5,544, p <0.05; eta = 0,049]). Hasil dapatan temu duga menyokong lagi hasil yang diperolehi daripada kajian kuantitatif. Bagi kesemua empat sub-skala literasi tenaga, pelajar dari kumpulan eksperimen menunjukkan perubahan yang jelas dalam jawapan mereka dibandingkan dengan pelajar kumpulan kawalan. Selain itu, guru-guru dan pelajar berpendapat pembelajaran tenaga berasaskan projek yang disyorkan melalui kajian ini adalah sangat sesuai untuk dilaksanakan sebagai komponen aktiviti kokurikulum. Selain daripada dapatan soal selidik dan temu duga, keberkesanan sumber pembelajaran tenaga berasaskan projek dalam meningkatkan literasi tenaga juga digambarkan melalui penulisan jurnal reflektif yang diperolehi daripada pelajar kumpulan kawalan. Justeru melalui kajian ini terbukti bahawa pembelajaran tenaga berasaskan projek yang dilaksanakan sebagai aktiviti kokurikulum dapatkan meningkatkan tahap literasi pelajar-pelajar sekolah menengah. Berikutan dengan keputusan ini, adalah disyorkan untuk pembelajaran tenaga berasaskan projek dilaksanakan sebagai aktiviti kokurikulum di semua sekolah-sekolah menengah di Malaysia.

THE EFFECTIVENESS OF PROJECT-BASED ENERGY EDUCATION IN PROMOTING SECONDARY SCHOOL STUDENTS' ENERGY LITERACY

ABSTRACT

Energy is the basic necessity for life. As we move into a future with limited fossil fuel 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. We need an 'energy literate' generation who will be able to make informed future energy choices, fostering a 'shift' in young peoples' attitudes, behaviors, belief and knowledge towards energy. Effective energy education program that strive to improve energy literacy claimed improve this situation. Project-based learning has been employed as a mean to improve energy literacy in various other countries and this initiative resulted in improving students' energy literacy. This study was conducted with the aim to investigate the effectiveness of project-based energy education resources in promoting Malaysian secondary school students' energy literacy which was carried out during co-curricular activities. For this purpose a total of 111 students from two secondary schools were assigned as experimental (N= 59) and control group (N= 52). Experimental group were taught using project-based energy education resources and the control was taught using more conventional method. Outcome of ANCOVA analysis of the questionnaire data shows that project-based learning significantly improved students energy literacy (knowledge [$F(1,108) = 79.570$, $p<0.05$; eta $=0.424$]; behaviour [$F(1, 108)=4.595$, $p<0.05$; eta$=0.041$]; attitude [$F(1,108)=5.297$,

p<9.05; eta= 0.047] ; belief [F(1, 108)= 5.544, p<0.05; eta =0.049]). The outcome of interview responses further supports the outcome obtained from the quantitative survey. For the four subscales of the energy literacy, students from experimental groups exhibited explicit changes in their responses compare to the control group students. Additionally, teachers' and students' interview responses also indicated that the project-based energy education resources suggested through this study is highly feasible to be implemented as a component of co-curricular activities. In addition to the quantitative survey and interview responses, the effectiveness of the project-based energy education resources in improving energy literacy also reflected in the reflective journal writing obtained from experimental group students. Hence, through this study it is an inevitable fact that project-based learning is one of the viable approaches to impart energy literacy to our students. Following this outcome it is highly recommended for the project-based energy education to be inherently implemented as co-curricular activities in the secondary schools.

CHAPTER ONE
INTRODUCTION

1.0 Introduction

One of the seven principles of sustainable development is to ensure sustainable use of natural resources (Kanden, 2012). It is about using energy wisely and using energy generated from clean sources and clean technologies. Wise energy use is the first step to ensure we have sustainable energy resources for present and future generations (Smith, 2012). Until the last fifteen years sustainable energy was thought of simply in terms of availability (Energy Linx, 2012). Today, considering other equally important aspects such as environmental effects, wastes and safety, therefore, sustainable energy is not just about using renewable energy but using energy wisely and introducing energy efficiency measures (The Guardian, 2012).

We need an 'energy literate' generation who will be able to make informed future energy choices, fostering a 'shift' in young peoples' attitudes, behaviors, belief and knowledge towards energy (De Waters & Powers, 2008). This is because energy-literate public will more likely be in the decision making process and will be better equipped to make a thoughtful, responsible energy-related decisions, choices and actions. Unfortunately, a number of studies had shown that people are generally ill-prepared to actively contribute to solving our energy problems, largely because they lack energy related knowledge and awareness (Phys Org.26, 2011).

Effective energy education program that strive to improve energy literacy will improve this situation precisely beginning from early childhood because it was reported that energy awareness and values are largely formulated during childhood (Stern, 1992; Zografakis, 2008). In fact, energy education in Greece is regarded as pivotal for instilling ''energy thrift and efficient behavior and attitudes in society''

(Zografakis, 2008). In the context of Brazil, the low-cost and long term investment in energy education resulted in conserving per kWh (kilowatt) of the energy invested (Dias et al., 2004).

Energy is the basic necessity for life. As we move into a future with limited fossil fuel 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. Energy crisis is a situation in which the nation suffers from a disruption of energy supplies such as oil accompanied by rapidly increasing energy prices that threatens economic and national security (Williams & Alhaiji, 2003). There has been an enormous increase in the global demand for energy in recent years as a result of industrial development and population growth. Supply of energy is, therefore, far less than the actual demand. The oil shocks of the 1970s led to worldwide economic hardship (Yergin, 1991), and the rapid run up in oil prices in 2007 led to food riots in Bangladesh (Dummett, 2008), trucker strikes in Spain (Fuchs, 2008), and has been cited by the International Energy Agency as a factor contributing to the 2008 global recession (IEA, 2009).

The accumulative effects derived from aforementioned energy crisis and the lacking of energy literacy noticed among general public further heightens the issue concerning global energy conservation. Hence, through this study efforts have been taken to adapt project-based energy education activities from various resources to tailor to the local context and these resources have been integrated as part of co-curricular activities involving secondary school students. The effectiveness of the project-based energy education in changing the students' energy literacy was measured as well.

1.1 Background of the study

Energy is the single most important technological challenge facing humanity today up to extend it is noted as nothing else in science or technology comes close in comparison.

> If we don't invent the next nano-widget, if we don't cure cancer in 20 years, like it or not the world will stay the same. But with energy, we are in the middle of doing the biggest experiment that humans will have ever done, and we get to do that experiment exactly once. And there is no tomorrow, because in 20 years that experiment will be cast in stone. If we don't get this right, we can say as students of physics and chemistry that we know that the world will, on a timescale comparable to modern human history, never be the same
>
> (Lewis, 2007)

In the quote above Lewis (2007) provided the challenges humanity will face in meeting its future energy needs. Lewis depicted that meeting the future energy needs will be difficult with the growing population. The world global population is experiencing exponential growth which expected to reach 70 billion in time to come (PBR, 2012). The alarming rate of population growth expected to increase the energy demand by five folds by the year 2050 (World Energy Council, 2012). The situation further deteriorated with mushrooming of industries locally as well globally. As early as 1972, Eklund (1972) had hypotheses that energy needs for the industrialized countries will double in every ten years (Eklund, 1972). This need expected to be sustained by the advancement of nuclear energy today whereby as it was forecasted in the 21st century nuclear power plant would be one of the main energy deriving

sources for most of the industrialized countries including Japan and US, even though these countries have experienced adverse effects from the operation of nuclear power.

In order to meet the energy demand for the future besides nuclear energy other various initiatives also had been taken at global level by organization such as UNESCO, World Energy Council and at the local levels by the government and non-governmental organization. For example, the government had a new ruling of tax exemption for the industries which were using their own waste to derive energy to support the energy requirement or industries which had switched towards renewable energy sources. The tax exemption also implied on the property owners who intended to build green buildings using green technology and general public who intended to buy hybrid cars (NGPT, 2010). In the 2012 Budget, tax for hybrid cars was reduced. This resulted in the lowering of the price of the car. The government's emphasis on the issues related to energy is further reflected when the Ministry of Energy, Water and Communication was renamed to Ministry of Energy, Green Technology and Water in 2009 (keTTHA, 2009). This Ministry through campaigns and advertisement had engaged in concerted effort to educate the general public on the importance and the urgency of conserving energy. These were some of the initiatives taken to address the need to switch to sustainable energy consumptions. This was perceived important because sustainable energy consumption is perhaps one of the effective solutions to address the global energy demand (CSCP, 2005).

Various studies have shown that it was imperative to educate the citizens on energy literacy (EERE, 2011). This is for the general public to be educated on sustainable way of consuming energy in their daily routine. Energy literacy includes promoting attitude, belief, behavior and knowledge (Brounen et al., 2012).

According to Pearson and Young (2002), energy literate person is a person having a basic understanding of energy concepts. The knowledge on energy, according to Pearson et al. (2002) will improve the person's self-confidence in issues related to energy whereby with this knowledge the person would be able to think critically and become active to participate in decision-making. The energy literate generation also reported to have the knowledge to make informed energy choices, which will foster a shift in young people's attitudes, behavior and belief in conserving energy (CCE, 2012). In this context the role of school was fundamental as the energy awareness was formulated during the childhood (CRES, 2008). The importance of education in imparting knowledge that could develop behavioral change and that could lead to sustainable lifestyle was also ruled out in the Agenda 21 of Chapter 36 (UNESCO, 2006).

Sustainable consumption of energy was included in the teaching and learning of various secondary and primary school curriculum (CDC, 2006). For example, in the primary curriculum energy was included in standard 5 science curriculum. In the contexts of secondary curriculum, the concept of energy was taught in form 4 chemistry. As an additional informal education component, Centre for Educational Training in Renewable Energy and Energy Efficiency (CETREE) was formed by the Ministry of Energy, Green Technology and Water in collaboration with Danish Environmental Cooperative Program whereby the main aim of CETREE is to increase the level of knowledge and awareness on the role and use of energy efficiency in schools and university (CETREE, 2009). Up to this end, 8, 260 students, 1,714 teachers and 14, 109 member of public have visited CETREE on learning tours (KeTTHA, 2009). Environmental education more generally and energy education more specifically also implemented as content of co-curricular

activities in Malaysia. To name few are Sekolah Rakan Alam Sekitar (SERASI) which was implemented in Sabah collaboratively with Shell (M) Sdn. Bhd; Water, Electricity Consumers of Malaysia (WECAM, 2009) has produce Energy Guide Book for primary and secondary schools. The guide books suggest various activities and these activities have been integrated into co-curricular activities.

Project-based learning was an alternative approach used to impart energy literacy of high school students in United Kingdom and various other countries (DeWaters & Powers, 2011). This approach found to be effective because this approach in classroom or school can invigorate the learning environment, energizing the curriculum with real-world relevance and sparking students' desire to explore, investigate, and understand their world (Fazio et al., 1983). Fazio et al. (1983) further asserted that project-based learning was filled with active and engaged learning, it inspired students to obtain a deeper knowledge of the subjects they were studying. The more fun and exciting the subject is the deeper the students will want to learn. Project-based learning also engaged them in realistic, thought-provoking problems. Despite significant effects obtained from project based energy education, literature on implementation of this education in local context was lacking (Govindan, 2000).

One possible and effective way of implementing project-based learning is through co-curricular activities (Kumar et al., 2014). This is because Kumar et al. (2004) asserted that co-curricular activities plays all-round development of children whereby these activities are prerequisite for social, physical and spiritual development of the student. Darling et al. (2005), compared the students who participated in co-curricular and who did not participate in these activities and commented as, “students who participated in school-based extracurricular activities had higher grades, higher academic aspirations, and better academic attitudes than

those who were not involved in extracurricular activities at all". Mohaney et al. (2003) found a positive relationship between co-curricular activities and inter-personal competencies, high aspiration and better attention level. Hollway (2002) studied effect on motivation and found it positive too. Similarly Bauer and Liang, (2003) showed positive effect on critical thinking, social and personal maturity. Hence the ultimate results of the studies indicated that co-curricular activities can contribute for enhancing academic achievements of the secondary school students (Bashir & Hussain, 2012).

As stated in the PBL handbook for teachers' co-curricular activities is an appropriate platform to integrate PBL (Jones, Rasmussen, & Moffitt, 1997; Thomas, Mergendoller, & Michaelson, 1999). This is because PBL is a model that organizes learning around projects. In the handbook also it was indicated that the projects are complex tasks, designed based on challenging questions or problems. When the students engaged in the projects it involves designing, problem-solving, decision making. Students should be given ample opportunities to work relatively autonomously over extended periods of time to produce realistic products or presentations. As such for this kind learning to take place, co-curricular activities would be the best possible way because co-curricular activities are the activities performed by students that do not fall in the realm of the ordinary curriculum of educational institution (Hay & Marais, 2011).

As Stevens (2000) suggested, PBL could be conducted as student-centred activities. These projects usually involve timely and real world issues. In other words, the projects are student-centred conducted in groups whereby during the projects students assume responsible positions of leadership in diligently assign the duties among the group members. The projects were also not

performed in fixed sitting arrangement and fixed timing as in the formal classroom. The projects were implemented in such a way that it allowed the students to move about. For instance, some groups were working in the canteen, in the school field and science labs. In terms of timing, it was suggested that the co-curricular activities is official meeting time for the students. However, they might also engaged in designing and searching information about projects beyond this timing (Rock & Levin, 2002).Among various clubs and societies, Reka Cipta club is one of the clubs aims to teach students about inventing new products. As such members of Reka Cipta club frequently involved in activities that requires problem solving and designing new products. The nature of Reka Cipta provides the platform for integrating and implementing PBL.

Simple changes in people's behavior can quickly lead to significant energy savings, but such changes will only happen, if people were aware of the energy consumption that they had the power to control. Therefore, there is a need to start with our secondary school students to be aware of the seriousness of the energy crises. These students are the future leaders of this world. These young minds should be guided to save our world for their good living. Lack of knowledge about energy was regarded as illiteracy, innumeracy and apathy (Newborough & Probert, 1994). Thus, there is an urgent need and it was also timely appropriate to impart energy literacy for these students. Therefore, in the context of this study, project-based energy education activities was adapted from various sources and integrated as part secondary school students' co-curricular activities. The effectiveness of the project-based energy education in promoting energy literacy of the students was measured.

1.2 Statement of Problem

> The Stone Age did not end because we ran out of stones, and the fossil-energy age is not going to end any time soon because we've run out of cheap fossil energy. Don't wait for that to happen (Lewis, 2007, pg 14).

In the statement above, Lewis (2007) clearly exhibited the urgency of the world occupant to conserve energy. Energy demand increased with the increase of population. This demand leads to the world energy crisis. Lewis (2007) asserted that the world populations' energy consumption rate was 13 trillion thermal watts and 85% of the energy comes from fossil fuel such as coal, natural gas and oil. The world population projected to be 1.7 billion in 2050, the rate of oil consumption was expected to increase in five folds. The current depleting status and exhaustion of fossil fuel reserve will further heighten the energy demand. One viable solution to this situation is by reducing the consumption and conserves energy through sustainable usage (EPA, 2010). Sustainable consumption of energy improved with energy literacy. This was reflected in one of the Newborough and Probert (1994) statement "the possibility of achieving the sustainable future increases with level of energy literacy".

Study showed that without a basic understanding of energy, energy sources, and generation, use and conservation strategies in other words energy literacy, individuals and communities cannot make informed decisions on topics ranging from smart energy use at home and alternative choices (Acikgoz, 2011). Despite this assertion a number of studies had shown that energy-related knowledge was disparagingly low (Barrow & Morrisey, 1987). This in fact reflected in a basic energy quiz conducted whereby only 12% of the participants managed to pass the

quiz (NEETF, 2002). Brounen, Kok and Quigley (2012) in a study involving 1, 721 Dutch households reported that energy literacy among the respondents were low. According to Brounen et al. (2012) only 52% of the respondents were aware of the monthly energy consumption and 60 % invest in energy efficient equipment. In a study involving 3708 secondary students conducted by DeWaters and Powers (2011), the level of energy literacy among the New York State students were discouragingly low. In another study, involving 400 secondary school students, Aktamis (2011) reported that students were less interested in issues related to energy.

Similar outcome also reflected in a study conducted by Lay, Khoo, Munting and Chong (2012) involving secondary school students in the State of Sabah. According to Lay et al. (2012) in a study involving 400 undergraduate students, students' behavior on conserving energy were at a minimal level. From Muhieldeen's et al. (2008) observation in a field study for four months, the students were noticed rarely perform energy conservation behaviors. The air-condition unit and lights were not turned off when not in use. Karpudewan, Ismail and Roth (2012) conducted a study to investigate the pre-services teachers' environmentally significant behavior and reported that these pre-service teachers rarely perform energy conserving behavior and frequencies of these teachers performing the behavior were also at a minimal level. In detail Karpudewan et al. (2012) reported that these pre-service do not wish to car pool, they preferred to drive and public transport was not a main mode of transport. They claimed it was not convenient to use public transport. In another study by Karpudewan et al. (2012) also identified that Malaysian primary school students very rarely performed energy conserving behaviour and their attitude towards conserving energy was minimal.

One of the education's major aims was to support students in developing a sense of responsibility towards their respective environment (Miranda et al., 2004). In this context, according to Miranda et al. (2004), schools played a significant role. The importance of education in imparting energy related knowledge also highlighted in the work of Acikgzo (2011); Kamath and Nesari (2001). In line with this, in Malaysian context energy was included as part of formal and informal learning. For example, in year 5 science the students were taught about what is energy, different types of energy, electricity and conserving energy. In the secondary level also energy was included in the Form 1 syllabus (CDC, 2003). Non –governmental organization such as Persatuan Penguna Air dan Tenaga Malaysia had produced Energy Guide Book for primary and secondary schools as part of National Energy Efficiency Awareness Campaign and this guide book had been distributed to the students (Persatuan Penguna Air dan Tenaga Malaysia, 2010) and used as co-curricular activities. Besides this, CETREE (2009) also engaged in various activities in educating the students informally. Despite these efforts and initiatives by various organizations the students' energy literacy level identified to be minimal. For instance, a study by Lay et al. (2012) found out that students in Sabah have minimal level of energy literacy and suggested that the implemented curriculum had failed to emphasises the relevance of energy-related issues to students' everyday life experiences.

One possible reason that hindered the effectiveness of the curriculum perhaps, was the strategy used in delivering the content. Yencken, Fien, and Sykes (2000) called for change in the approach used to deliver knowledge towards constructive approach by integrating materials from a wide range of sources for the education to bring adverse pro-environmental impact. Kaivola (2004) asserted

sustainability could be reached with a student-centred approach, or ‘deep approach’ whereby students seek meaning for themselves. According to Kaivola (2004), ‘deep approach’ generally leads to higher levels of academic understanding and greater likelihood of being able to transfer their knowledge and skill to similar real-world context. In teaching and learning of current curriculum these approaches rarely used or it was absent totally. What predominant in the current schooling was teacher centred whole class teaching whereby the focus of the teaching was solely to prepare the students to answer examination questions. Managenergy (2004), in fact highlighted the point that a typical school curriculum with lessons on energy integrated into was not sufficient to deliver chances and suggested project-based learning would be an alternative and effective approach to deliver lessons on energy. However, in the local context even though various approaches had been used to deliver lessons related to energy, project based energy education was still at infancy (Lay et al., 2012)

The importance of conserving environment generally had been stressed during the co-curricular activities through ‘Kelab Pencipta Alam’ (MOE, 2006) and ‘Reka Cipta’ (MOE, 1995). However, the question was to what extend the activities of this particular club highlights the importance of conserving energy? Perhaps, energy was included as one of the component in the environment and the importance of it was not heightened during the activity (MOE, 2006). Up to this end the literature on project-based energy education in Malaysian context is still minimal.

Thus, in this study, project-based energy education module was adapted and tailored to the Malaysian context from various sources and the effectiveness of this education in promoting the energy literacy of secondary school students was

measured. This enrooted a path for project-based energy education to be implemented as co-curricular activities.

1.3 Purpose of the study

This study aimed to investigate the effectiveness of project-based energy education in enhancing secondary school students' energy literacy. For this purpose project-based energy education activities have been adapted from various other sources (Hill, 2005, DeWaters & Powers, 2008) and tailored to the need of the local context. The adapted project-based energy education resources were integrated as part of the co-curricular activities and the effectiveness in promoting students' energy literacy was measured. Additionally, feasibility of integrating the project-based energy education resources as co-curricular activities were obtained from the teacher's and students' perspective.

1.4 Objectives

The purpose of the study was supported by the following objectives:

1. To measure the effectiveness of project-based energy education in enhancing secondary school students' energy literacy in terms of knowledge, behavior, attitude and belief about energy.

2. To discover the feasibility of integrating project-based energy education as a component of co-curricular activities from teacher's and students' perspective.

1.5 Research Questions

In line with the objectives of the study following research questions have been formulated:

1) What is the effectiveness of project-based energy education in enhancing students' energy literacy? Specifically what is the effectiveness of the project-based energy education in improving students'
    - Knowledge about energy?
    - Behaviour about energy?
    - Attitude about energy?
    - Beliefabout energy?

2) A. What are the feasibilities for integrating project-based energy education module as part of co-curricular activity from teacher's perspective in terms of:
    a. What are the teacher's opinion about the project-based energy education modules?
    b. What are the challenges faced by the teacher in carrying out the activities?

   B. What are the feasibilities for integrating project-based energy education module as part of co-curricular activity from students' perspective in terms of:
    a. What are the students' views of the group work?
    b. What do the students think about the class?
    c. How the students could use some of the strengths and accomplishments obtained during the projects to help them in future undertakings?
    d. What are the students' opinion about the learning during the project?
    e. How do the students like the projects?
    f. Did these activities have everything to do with the changes in learning about energy?

1.6 Hypothesis

Ho 1: There is no significant difference between control groups and experimental group's post test mean scores for the construct on knowledge about energy in the questionnaire on energy literacy after controlling the pre test scores.

Ho 2: There is no significant difference between control groups and experimental group's post test mean scores for the construct on behaviors about energy in the questionnaire on energy literacy after controlling the pre test scores.

Ho 3: There is no significant difference between control groups and experimental group's post test mean scores for the construct on attitude about energy in the questionnaire on energy literacy after controlling the pre test scores

Ho 4: There is no significant difference between control groups and experimental group's post test mean scores for the construct on belief about energy in the questionnaire on energy literacy after controlling the pre test scores

1.7 Rationale of the Study

The intention of this research is to improve the energy literacy of the students which expected to result in more sustainable everyday energy practices. Effective programs that improved energy literacy will help to draw students toward further studies and careers in the growing fields of energy-related engineering, science, and technology. This in turn would assist students to interpret energy issues and made sound choices as they became adults.

Energy literacy was an understanding of the nature and role of energy in the universe, and in our lives. Energy literacy also encompasses application of the understandings about energy in solving every day issues related to energy. An energy-literate person could trace energy flows and would thought in terms of energy systems. This person would know how much energy he or she used, for what, and where the energy came from. This energy knowledge assessed the credibility of information about energy and enabled the person to communicate about energy and energy-use in meaningful ways. So, an energy literate person would be able to make energy-use decisions based on an understanding of impacts and consequences.

Efforts to promote energy literacy – a citizenship understanding of energy that included attitude and behavioral aspect – would help people to become actively engaged in making energy-related decisions that would better their future. This educational research study intended to improve our understanding of how energy education could be improved energy literacy among the secondary school students. Without a basic understanding of energy, energy sources, generation, use and conservation strategies, individuals and communities unable make informed decisions on topics ranging from smart energy use at home and consumer choices to national and international energy policy. And the current national and global issues such as the fossil fuel supply and climate change highlighted the need for energy education. The aim and philosophy of project-based education as suggested in this study is parallel with the aims of co-curricular activities. One of the prominent purposes of the co-curricular activities is to extend the learning that occurs formally during the schools hours to after school hours.

1.8 Significance of the Study

The experiments and finding obtained through this study is resourceful for the students, teachers, curriculum planners and policy makers. For the students the project-based energy education modules increased engagement and enthusiasm for learning and provided greater student pride and ownership in accomplishment. A better understanding of energy could also lead to informed decision and also to improve the security of a nation. Indirectly it would also promote economic development. The projects also would lead to sustainable energy-use and it would also help to reduce environmental risks and negative impacts.

For the teachers, the project-based energy education modules proposed through this study would be a good guide for them to integrate energy education during co-curricular activities. The existing energy education material appears to be present information about energy in the decompartmentalized manner. This resulted in the teachers unable to effectively education the students on the holistic view about energy. The project-based energy education resources recommended through this study provide a complete guide on how to implement energy education as co-curricular activities.

For the curriculum planners the study is resourceful mainly because through this study the curriculum designers would provide information on students' level of energy literacy. Following low level of energy literacy it alarms the curriculum developers to integrate issues of energy during teaching and learning process. However, due to overwhelming amount of existing curriculum content probably it will be a hassle for the developers of curriculum to introduce entirely a new syllabus on energy. The project-based energy education as proposed through study would be

an alternative for the designers to consider as it introduces a holistic energy education curriculum without adding on to the existing overwhelming content.

For the policy makers the outcome of this study provides useful information about the students' energy literacy. Based on the outcome reported in this study the policy marker could actually anticipate the literacy of the general public in future. Outcome of this study in one way embark the policy makers to design policies so that the general public would adapt more energy saving behaviors.

1.9 Limitation of the Study

The duration of the study was only 10 weeks. If the duration of the study was prolonged there would be a higher probability to produce more accurate result. According to Rokeach (1973) significant changes in the literacy can be detected between 3 to 5 weeks of treatment. He claimed that continuous exposure enhances the value formation. In this study, 3 projects were included as project-based energy education. If more projects were included probably the significant of the results obtained could be further improved.

The approach used in this study also limited the generalization of the study. Generalization was limited because the sample in the study it involved a school in an urban area. The research might give a different reading if done in rural area. The results would not be generalized to other schools. Perhaps, the study needed to be repeated in the rural schools to identify the impact.

The project-based education modules were meant to allow all the students to engage in the projects at the same time and work in partnership, however, there are some limitations associated with it. One of the limitations is the time management where some groups took longer time to finish their project. It sometimes took longer

time for some students with different learning pace to come up with the outcome of this project especially solar oven. Cost factor in doing the project is also a limitation. Some students cannot afford to share the cost of production especially of producing solar power oven when the other members in that group wanted to use only good materials for it. Perhaps, the study needed to provide all the necessary things for the projects and encourage the usage of recycling products to do this project and train the facilitators to motivate and speed up the group projects.

1.10 Operational Definitions

Energy literacy: Energy literacy is defined as a baseline fluency and knowledge of the complexities related to energy and energy use. According to DeWaters and Powers (2011) energy literacy consisted of three components: cognitive, affective and behaviours. In the context of this study based on the work of DeWaters and Powers (2011) energy literacy encompasses students' knowledge, behaviour, attitude and belief about energy.

Knowledge about energy: According to Webster's Dictionary, knowledge is the fact or condition of knowing something with familiarity gained through experience or association. Knowledge refers to the ideas or understandings which an entity possesses that were used to take effective action to achieve the entity's goals (Denning, 2005). An example of knowledge about energy would understand that the kilowatt-hour is the basic measure of electrical energy.

Behavior about energy: Behavior is the range of actions and mannerisms made by organisms, systems, or artificial entities in conjunction with their environment, which included the other systems or organisms around as well as the physical environment (Jespersen, 2012). Behavior about energy refers to specific things that can be done to reduce energy use, such as turning off lights when leaving a room.

Attitude about energy: Attitude is a predisposition or a tendency to respond positively or negatively towards a certain idea, object, person, or situation and influences an individual's choice of action (Prakash et al., 2013). Attitude about energy reflects tendency for opting towards more energy conservation strategies.

Belief about energy: Belief is defined as the ability to do what was defined as desired or to be effective at producing a result or the ability to produce a desired or intended result (Bandura, 1996). Belief about energy reflects on the students' belief that their action can bring changes.

Project Based Learning: Project-based learning is an authentic learning model or strategy in which students plan, implement, and evaluate projects that have real-world applications beyond the classroom (Blank & Harwell, 1997; Harwell, 1997; Westwood, 2008). A systematic teaching method that engaged students in learning essential knowledge and life-enhancing skills through an extended, student-influenced inquiry process structured around complex, authentic questions and carefully designed products and tasks (McGrath, 2003).

Project-based Energy Education Module: A collection of real world project-based energy education module that represents authentic real world energy issues (DeWaters & Powers, 2011). In the context of this study, the projects are mind mapping, solar oven and biodiesel.

Co-curricular activities: It is referred to as extracurricular, extra-class, non-class, school-life, and student activities (Tan & Pope, 2007).These activities were performed or carried as the annual programs of the uniformed bodies, visual and performing arts, clubs and societies. PBL comprises one of the annual activities of the uniformed body the Reka Cipta.

Reka Cipta: Reka Cipta is one of the co-curricular clubs. The activities implemented by this club intended to developing vention and innovation culture among the students. The activities are aimed to nurture creativity and problem –solving abilities among students. Project based Learning comprises as one of the activities.

1.11 Summary

This chapter started with an introduction followed by detailed background of the study and the statement problems. The purpose of study and objective of the research was explained. This chapter also discussed the research questions and hypothesis. This is followed by the elaboration of the rationality of the study and the significance of the study. This chapter ended with the limitation of this study and provided definitions for important terms used throughout the writing.

CHAPTER TWO
LITERATURE REVIEW

2.0 Introduction

The main aim of this study is to investigate the effect of project-based energy education in promoting energy literacy of the secondary students. This chapter begins with a discussion about global energy status, literature review on environmental education and energy education. Additionally, this chapter will illustrate on project-based learning; energy education as project-based education and project-based energy education integrated as co-curricular activities. This will be followed with review literature on energy literacy. This chapter ended with illustrating the theoretical and conceptual framework that governs this study.

2.1 Global Energy Status

> Our world runs on energy: energy it's fundamental to our way of life and growing of our economy. Energy is essential for everything from fueling our cars to heating our homes to powering the appliances we depend on daily. But the world is changing. An expanding population, economic growth, new technology development and changes in the nature and scope of regulations are all transforming the energy landscape. (The outlook for energy: A view to 2040, 2010)

The above quote indicates the important role of energy in every aspects of an individual and it determines the way people live. International Energy Agency in their Key World Energy Statistics (2012) reported that global demand for energy has risen inevitably in the last 150 years in line with industrial development and

population growth. The stipulate for energy is predicted to continue to rise, by at least 50% by 2030, as developing countries like China and India seek to fuel their rapid economic growth (Tillerson, 2012) and population which expected to rise 25 percent from the year 2010 to 2040. According to Tillerson (2012) total population of the world expected to reach nearly ninebillion. The World Energy Outlook (2012) predicts that world demand for energy will increase from 2,000 million tons of oil to 16,800 million tons in 2030. Figure 2.1 illustrates the trend in the increase in energy demand with population.

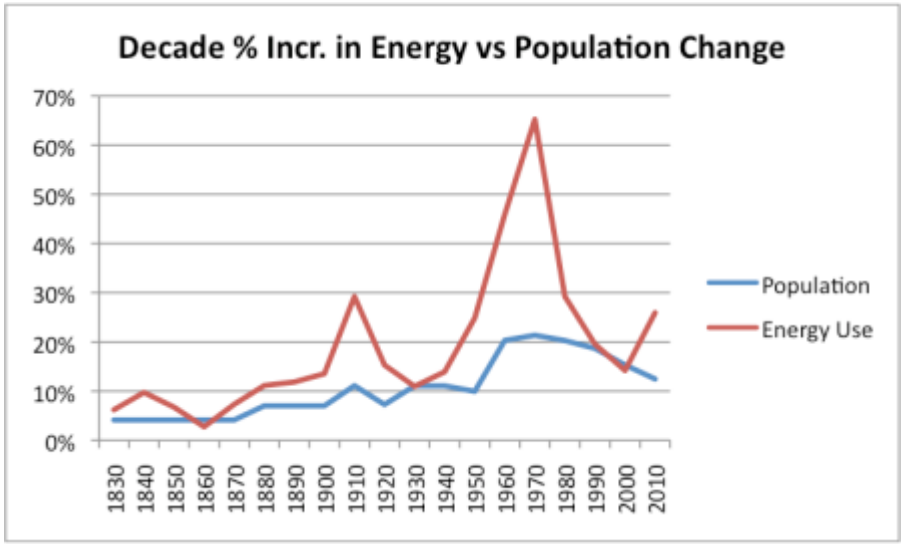

Figure 2.1 Show the increase in the energy demand versus the population change (Adapted from World Energy Consumption, 2012)

According to the latest 2010 World Energy Outlook, in two decades, China will undoubtedly be the most important force in global energy market. As China is the world's most populous country and the largest energy consumer in the world it has rapid increasing energy demand that has made it extremely influential in world energy markets and it is the world's second-largest consumer of oil behind the United States, and the second-largest net importer of oil as of 2009 (EIA, 2013). The

momentum of economy development looks to set to generate strong growth in energy demand in China. The primary energy demand in 2030 is expected to continue in an increasing trend as indicated in Figure 2.2.

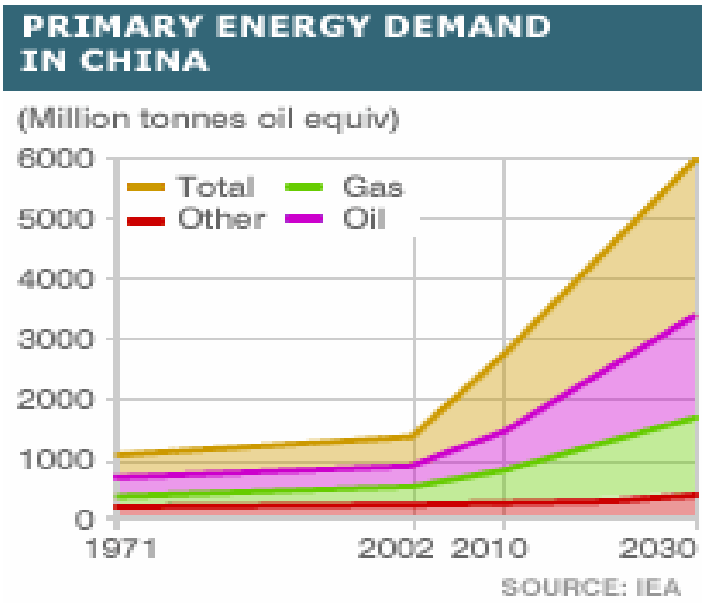

Figure 2.2 illustrates the demand for energy in China. (Adapted from EIA, 2013)

According to IEA from 1971 to 2030, the total usage of primary energy is forecasted to increase from 1000 million tons in 1971 to 6000 million tons in 2030. The IEA predicts natural gas to overtake coal use within next decade. Thus gives oil and gas price to increase (Jamil & Ahmad, 2010). China's expanding energy market, the rate of growth in China's energy demand and China's entry in world trade organization needs ample supply of energy (Rangaswamy, 2007). Industrialization in emerging economy countries created a requirement for larger amount of energy in the form of both electricity and petroleum-based fuels in order to operate. Industrialization has resulted in increase of wealth which increases the life style with consumers owns their own cars, air conditioners, refrigerators and other energy hogs. These in turns increase the usage of energy in daily life. Globalization is also another cause for energy demand. OECD (2004) report indicates that with globalization