The Effectiveness of Integrated Stem in Enhancing Energy Literacy Among Primary School Students in Malaysia

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ABSTRACT: *The main aim of this research is to examine the effectiveness of STEM integration in increasing the energy literacy of primary school students. The research design of this study includes the description of the mixed method research (MMR). Both quantitative and qualitative approaches of data collection are performed in this study as it employs MMR. This research has conducted both the survey and interview to collect data and it is a useful technique to enhance the validity of the research. Additionally, use of primary data in the research has involved the quality data and protects the reliability factors as well. In the quantitative study, a quasi-experimental design involving two groups which is the experimental group (EG) and control group (CG) were used. Qualitative approach which focuses on the interviews, analysis of interview data, and open-ended questions were used to get the insights of this study. This study indicates that Malaysian primary school students' energy literacy is in high level after the implementation of integrated STEM. The analysis of the data has highlighted the actual situation in Malaysia to develop this practice in the primary level of education. It is important to meet the objectives of the research and portray the recent development of energy literacy as well in Malaysia. Students are typically aware of and accept the presence of energy challenges, are concerned about energy conservation and renewable resource use, and have apparent positive attitudes and values about energy, which is consistent with previous findings.*

KEYWORDS: *energy education, energy literacy, energy security, primary school, stem integration*

I. INTRODUCTION

In this modern age, energy is viewed as a universal commodity. Institutions and individuals extremely depend on constant access to energy in all its forms (Oo et al., 2017). Energy is substantial to all mankind on this earth because it is the substance of civilization and advancement. Modern life would not be a reality without energy (Mohammed & Wai, 2010).

Energy is a limited resource and it is bound to run down sooner or later. In the 1970's, lack of awareness among citizens may cause wastage of energy when the energy resources are inexpensive and cheaper. Citizens believe the energy resources are abundant until the energy crisis occurs in 1973 and 1978. Both crises brought direct global economy impact where even schools were closed down to save on energy. After nearly three decades of crisis, the effected countries seemed to forget and they start using a great amount of energy without attentiveness and thoughtfulness again (Mohammed & Wai, 2010).

Many renewable resources, energy competence devices, energy sustainability actions, and energy policies were extensively and broadly accepted in many countries. However, none of these really give a direct impact on the citizens of these countries (Oo et al., 2017). With the rapid development in most of the countries, energy consumption increases very fast and reduces the availability of renewable energy resources. The global energy market is still dominated by petroleum and natural gas, which will deplete eventually. Unsuitable and unfavourable usage of energy is snowballed and increased with many critical environmental issues such as the greenhouse effect (Mohammed & Wai, 2010). According to Adam (2006), most of the greenhouse effect is caused by burning fuels for energy.

Another critical issue is energy sustainability. Sustainable supplement of energy in the coming future or future generations is a great challenge to all (Mohammed & Wai, 2010). According to Agenda 21 in attaining a sustainable society, it outlines encouraging environmental and ethical awareness, values, attitudes, skills, and behaviours required for sustainable development (Jennings & Lund, 2001).

In a survey, 90% of the respondents stated that energy conservation measures should be taught in school (Dickson et al., 2011). The respondents believe giving more importance to educating students can help to overcome energy problems. The pupils should realize that their easy actions can make them more energy efficient in their daily live practice. The public should aware that they have a lot of power in their hands to solve energy problems.

The small corrections they make in their daily life can make a big difference in the future. This only can be done through adequate guidance through education. Energy education can create awareness and confidence in choosing the right

solution in a positive way. Education can create changes in values and attitudes, skills, and behaviours by exposure to the issues of sustainable development (Bernardino, 2000).

Therefore, energy education is the best way to cultivate energy awareness, which is the major phase to attain energy sustainability and energy efficiency. Efforts to promote energy conservation are incomplete without proper energy awareness in people. It is the seed for tomorrow's future. This is the reason energy literacy is increasingly incorporated into the education curriculum of many countries (Aguirre-bielschowsky, 2013). Energy studies are quickly evolving as a new discipline (Jennings & Lund, 2001). It is about creating energy professionals and constructing a more energy-literate society through a compulsory primary and secondary education (Zografakis et al., 2008). In this study, the later part has been taken into consideration on creating an energy literated society.

Information through education makes a significant difference in their approach towards more rationale use of energy. By emphasizing this in the early age, the pupils can develop and transform themselves into sustainable energy friendly consumer and citizen when they grow up. These transformed pupils, turn into tomorrow's citizens, are expected to inspire their peers and other people in their surroundings such as family, relatives, friends, and neighbours. A well-quipped energy literacy person, able to make wise energy decisions based on the impacts and consequences. An energy literated person is said to be aware how much energy needs to be used, for which purpose and the source where it came from. This person is capable of communicating about energy and energy use in meaningful ways (Mascone, 2013).

Energy literacy can lead to more informed decisions, lead to sustainable use, and reduce environmental risks or negative impacts. Energy literate person has a basic understanding on how energy is used in everyday life, the impact of energy consumption, energy conservation, the need for an alternative to fossil fuel-based energy resources, and strives to make better energy choices (J. DeWaters et al., 2007). According to the energy literacy framework and instrument developed by Dewaters & Powers (2013), energy literacy encompasses three dimensions of content knowledge, affective, which consists of attitudes, values, and belief, and the last dimension is behaviour.

As one of the dimensions of energy literacy, knowledge can be defined as the element that associates with cognitive practises such as recalling, examining, and constructing, which are known as a crucial factor of literacy. Energy related knowledge is still poor among the general public (Aguirre-bielschowsky, 2013). In the same study, it has been conveyed that some studies have found that half of the respondents in the USA failed a basic energy quiz. Over 40% of the respondents cannot name a fossil fuel or renewable source, 56% of them think that nuclear power contributes to global warming, and the majority overestimate renewable energy production.

Energy-related knowledge is therefore one of the key areas to be nurtured and understood by school children. If energy-related knowledge is neglected, the advancement of science and technology could be effected. Characteristics for the attributes of knowledge consist of basic energy concepts, energy sources and resources, and environmental or societal impacts. The measurable benchmarks for the characteristics of basic energy concepts are identifying forms of energy, understand the first and second laws of energy, and identify units of energy and power (J. DeWaters & Powers, 2008).

Attitude is one of the most vital and important concepts in social psychology (Ajzen, 1991). It is also best studied in relation to children and energy (Aguirre-bielschowsky, 2013). Attitudes lead to faster, easier, and better decision-making skills (Baumeister & Bushman, 2008). Attitude includes sensitivity or awareness to global energy issues, positive energy related attitudes, and efficacy beliefs (J. DeWatersm & Powers, 2013).

If a child has never thought about his energy consumption, he cannot have an attitude towards it. Ayers (1977) stated that primary school children support nuclear energy advancement and development without knowing the probable threats it can bring on. These students also detailed that the fossil fuel usage should not be longer used for environmental reasons to generate electricity. This signifies less understanding of energy issues and a projection of their attitudes towards complex issues (Aguirre-bielschowsky, 2013).

High school students also support nuclear energy production and trust new discoveries will resolve energy problems. Results from other studies have stated that teenagers show less attention in saving electricity than their parents and often perceive this as an inconvenience (Toth et al., 2013). Therefore, attitudes without amendment and improvement at the early age can influence them in making wrong energy related decisions. They tend to have various attitudes toward energy issues and are not prone to conduct energy conservation measures. (Keirstead, 2006).

Belief was measured as a psychological domain (Barber, 2011). Belief includes the trust that environmental issues can be solved by using improved technology and the reliance of human on their rights to modify the natural environment to suit their needs. When students perform energy saving conducts according to their beliefs to contribute to an energy solution or environment protection, a positive act will be formed in person.

Usually, families with very strong environmental values will prompt environmental concern. These values are usually accepted by parent to child as a fundamental part of their special individuality, and in future the urge to save energy may come naturally to themselves out of environmental concern (Toth et al., 2013). Its undeniable that childhood is important because values related to environmental and energy efficiency are largely formulated during this time through family socialisation (Aguirre-bielschowsky, 2013). Frequently, values are raised in discussions on how to develop a more

sustainable relationship with the environment. Stable principles of value help us make wise choices when our preferences are in conflict. Values provide solid guidance on making collective decisions (O'Neill et al., 2007).

A behaviour is an observable apparent act of a person. Prior research has shown that a change of behaviour towards energy issues can decrease household energy consumption by up to 22% and electricity use by up to 19% (Abrahamse et al., 2005). Most of the daily household activities have the potential to accommodate energy saving behaviours. Usual behaviours will grow and adapt from one's personal experience and will be motivated or encouraged by the society's approval. Family which contributes a good example for children shows positive behavioural aspects (Cialdini & Goldstein, 2004). Positive changes in behaviour can help to reduce energy consumption by using energy more efficiently, buying more energy efficient appliances, and taking energy conservation measures.

Review of many literatures showed that changing the behaviour of people can solve the energy demand (Ting et al., 2011). Extra consumption of energy rises from people's wasteful behaviour on energy usage and almost half of the energy consumed by users are wasted. People didn't realize that changes in their behaviour can give immediate energy cost savings (Ting et al., 2011).

The main concern on energy issues is the ability of a country to cater the people's needs and the rapidly increasing energy cost. Although many energy conservation strategies have been taken, teaching these attributes to small is the most important step (Toth et al., 2013). In order for students to have proper energy literacy, the topic energy should be delivered properly. For example, the use of a project-based learning method enables students to learn about renewable energy and at the same time value the significance of renewable energy in real life. These findings are consistent with the study of Lau and Lee (2010) who reported that the use of weblogs in education helped to increase awareness and cultivate student interests, making students more sensitive to energy problems. Science educators should be proficient in contributing learning experiences that engage students in realistic, thought- provoking problems, working with others, and applying their knowledge, skills, and creativity in finding solutions to real-world problems (Siew et al., 2015).

Therefore, an appropriate method of teaching must be emphasized and utilized carefully to make sure the exact content of energy can be delivered to pupils when they are still at the primary level. Despite using all these approaches, low literacy to energy is prevalent. Due to the complex, abstract, and interdisciplinary nature of energy literacy which also involves science, society, and politics, usually energy topics are difficult to teach and to be learned (Boylan, 2008). It requires an interdisciplinary approach such as integrated STEM. This is because energy is neither tangible nor visible. It is measured in a variety of units that involve important cognitive skills to understand and convert, particularly around the age of 15. Young children especially feel it very hard to measure the consequences of its production and consumption (Pierce & Paulos, 2010).

Integrated STEM education is an effort to combine science, technology, engineering, and mathematics into one class that is based on connections between the subjects and real-world problems (Stohlmann et al., 2012). Learning through multiple, integrated subjects creates better understandings, skills and higher attainment. Usually, any real-world issues and problems encompass more than one discipline. Activities such as designing alternative energy systems based on solar or wind energy, maintaining a clean water supply, or sustaining ecosystems will involve practices across the STEM disciplines (Honey et al., 2014).

Although family plays an important role, peers also mainly play a substantial part in producing a norm encouraging awareness on energy conservation. Therefore, in this study, to recommend an extended vision which embraces more global perspectives, much priority is given on how the pupil's attitudes, knowledge, behaviour, belief, and values shifted from personal level to social and next to the global level as well. As we move from a context that focuses on the individual and society to a more global context, our community needs to rethink what all students need to understand on energy literacy to live in the 21st century.

II. STATEMENT OF PROBLEM

The results of a study in Taiwan among 1,711 secondary school students indicated that the energy literacy level is critically low (Chen et al., 2015). Research involving 2708 secondary students in New York State pointed out that the pupils were lack of knowledge that are necessary for solutions and choices to be made when comes to energy-related issues (J. E. DeWaters & Powers, 2011).

Many researchers have stated in their outcomes that children's energy knowledge to be poor, with both primary and high school students lacking a sound understanding of basic scientific facts, the socioenvironmental implications of energy production and consumption, and general trends in resource use and supply (Ayers, 1977; Barrow and Morrisey, 1989; Bodzin, 2012; Bodzin et al., 2013; Boylan, 2008; Chen, 2011; Davis, 1985; DeWaters and Powers 2008, 2011ab; DeWaters et al., 2013; El-Salam et al., 2009; Erdogan and Ok, 2011; Gambro and Switzky, 1996; Ivy et al., 1998; Jentsch et al., 2011; Lawrenz, 1983; Solomon, 1985; Solopova, 2008; Stubbs, 1985; Sudderth, 1984) in (Aguirre-bielschowsky, 2013).

In a survey by Bittle, Rochkind and Ott (2009), it has been stated that 40% of respondents were incapable to state the source of fossil fuels and renewable energy sources (J. E. DeWaters & Powers, 2011). Findings from an internet-based public opinion survey at Massachusetts Institute of Technology conveyed that most of the respondents had no knowledge or read about hydrogen cars, wind energy, or nuclear energy and 17% of the respondents had not heard about any of these words before (J. DeWaters & Powers, 2008). A web-based survey was done to measure the energy literacy of people in Japan and examined how it affects the consumers' preferences towards Energy Mix, power providers, Monthly Electricity Fee, and CO2 intensity. In that study, people in Japan do not have sufficient knowledge of energy regarding energy literacy levels, economy and energy, and environment and energy seemed to be particularly difficult for the respondents (Nakai et al., 2017).

In a study carried out among 276 Form 2 students, it has been indicated that the students' understanding of energy concepts was very low, especially on cognitive questions (Khoo & Treagust, 2013). The result from a study done on from two students from Sabah showed that the students showed lack of knowledge towards energy solutions in the environment. (Mohd Ali Samsudin, Abdul Hadi Harun, Norfarah Nordin & Hasyimah Haniza, 2014). Past studies revealed that students have a less positive attitude about energy issues, especially about renewable energy (Bittle et al., 2009; Curry et al., 2007; DeWaters, 2011a; Hilal, 2011; Lawrenz, 1985; NEETF, 2002; Howcast, 2005; Manville, 2008) in (Mohd Ali Samsudin, Abdul Hadi Harun, Norfarah Nordin & Hasyimah Haniza, 2014). In a study done on Taiwanese secondary students, the sample's results on dimensions of low carbon, lifestyle, and reasoning on energy issues had the lowest percentage of correct responses in all given assessments.

According to a research based on two exploratory studies, the 14-item Sustainable Development Favourable Behaviours Index showed the worst behaviour level in a sample based on 269 students of grades 6,8, and 9 in Manitoba Canada, with a low $\alpha = 0.63$ and an average item total correlation of 0.26 (Michalos et al., 2009). The same goes to another research where the undergraduate students' behaviours on conserving energy were also very low based on research by Lay et al. (2012) on a sample of 400 undergraduate students. From an observation in a four-year field study by Muhieldeen's et al. (2008), it has been reported that the students were hardly performing energy conservation behaviours such as the air condition unit and lights were not turned off when no one were using it. According to a study by Karpudewan, Ismail and Roth (2012) investigating the preservices teachers' environmentally significant behaviour, it has been stated that these preservice teachers apply energy conserving behaviour rarely and the frequency of these teachers engaging in this behaviour was also at a minimal level. Karpudewan et al. (2012) explained in detail that these preservice preferred to drive and do not want to car pool or use public transport as a mode of transport claiming it's not convenient for them. This has been added by another statement by Karpudewan et al. (2012) in another study, stating that Malaysian primary school students hardly ever performed energy conserving behaviour. This statement has been supported by another study in Malaysia, which exposed those students who were instructed in the field of environmental education still have failed to show awareness and commitment regarding environmental issues. The energy literacy level of students generally is still at a low level [Aini, Laily & Sharifah, 2009; Arba'at, Kamsiah & Susan, 2009; Fatimah, Norliza & Salhayatin, 2011; Zohir, 2009] in (Mahat et al., 2016).

In the process of being a developed nation towards Vision 2020, the education system of Malaysia has to also play a major part in cultivating Malaysians in recognizing and aware of global problems and challenges on energy issues as well. However, it is very saddened to state that Vision 2020 and 11th Malaysian Plan didn't touch upon the concern for the environment in their outlines. Same goes to the Malaysia Education Blueprint (MEB) 20132025 and Malaysia Education Blueprint (Higher Education) 2015-2025. These two blueprints also lacked to show the concern for sustainability, sustainable development goals, or the environment (Wan et al., 2018). Even, the 11th Malaysian Plan didn't specialise outlines on the role of STEM in terms of education. This shows a lack of emphasis to indoctrinate the concern and competencies of Malaysian students in this important field at the primary and at the secondary level as well. There is an urgent need to re-humanise education which involves and gives more priority to energy literacy. Studies on renewable energy in Malaysia extensively cover the technical and regulatory advancements of new technologies for mass use. Studies on social barriers and users' attitudes towards renewable energy are yet to emerge in the public domain. Therefore, users' experience with and their attitude towards renewable energy is yet to be rightly explored (Alam et al., 2016).

Research carried out on Sustainable School Environment Award (SLAAS) that has been implemented since 2005 in Malaysia. It is not made compulsory by the Ministry of Education of Malaysia. A questionnaire survey was administered to 447 pupils to evaluate the effects of the SLAAS (Mahat et al., 2016). Another study was done where the primary data were gathered from 447 students and 245 teachers of six secondary schools in urban areas and six secondary schools in rural areas which participated in the SLAAS Programme as well (Mahat & Idrus, 2016).

Research is done on the potential for applying renewable sources such as solar, wind, and hydropower e for rural electrification is investigated, especially in the poorest states of Malaysia (Borhanazad et al., 2013). One study has been done at the primary level of students in Malaysia to identify the level of carbon foot print from electricity consumption as well as the relationship and effects of sustainability knowledge, green knowledge, and sustainability practices towards electricity consumption in primary schools. This study investigated carbon footprint analysis involved 423 students from ten primaries the district of Batang Padang, Perak, Malaysia (Mahat et al., 2018). Another study at primary level was done

to investigate the effectiveness of project-based energy education resources in promoting Malaysian secondary school students' energy literacy. This research was carried out during co-curricular activities involving 111 students from two secondary schools (Jamunah, 2016).

At a secondary level of form two, an investigation on students' energy- related knowledge and attitudes toward their energy- related behaviors was done in Sabah, Malaysia. In the Malaysian context, past studies were done more in secondary and tertiary level of education in Malaysia and there was no study on primary level. Existing studies on the primary levels reported on environmental rather than specifically on energy literacy.

Although the concern and awareness on energy literacy is increasing, but far too little attention has been paid to primary school students' energy literacy and STEM. Hence, this study will be added on to the literature, as it addresses the effectiveness of STEM approach on energy literacy among primary school students. There're no researches that have comprehensively measured energy literacy among primary school students in Malaysian context using STEM approach. Therefore, here in this study, to rectify these issues, the emphasis is given to STEM integration as an interdisciplinary practice and as an alternative to teach energy literacy among primary school students.

Other than that, priority was given to the expansion of this integration from the personal level to the societal level to the global level as well. As the context of human life expands from personal to global, a new vision of scientific literacy is needed in energy literacy as well (Choi et al., 2011). The energy issues such as global warming, lack of energy resources, pollution of waterways and air are stretched from personal to societal and global. These issues will only be solved through collaboration, communication, and cooperation between people who see themselves as members of a global community. Personal level change and awareness making wise energy choices without compromising the ability of future generations to encounter their own necessities is essential.

III. PURPOSE OF THE STUDY

This study is designed to investigate the effectiveness of integrated STEM in enhancing primary school students' energy literacy. Energy literacy includes knowledge, attitudes, behaviour, and beliefs about energy.

IV. OBJECTIVES OF THE STUDY

The objectives of this study are: -

1. To investigate the effectiveness of STEM approach in enhancing primary school's energy literacy.
2. To assess the dimensions of energy literacy which includes knowledge, attitudes, beliefs, behaviours, and values from the personal level to society level to the global level.

V. LITERATURE REVIEW

Energy education has been stimulated since 1979 in many countries like the United Kingdom, the United States, and Australia (Hsu, Huang, Fu, & Teng, 2010). To ensure the accomplishment of an energy education program, a complete assessment of educational objectives parallel with the criteria for energy literacy is very much needed. According to Mohd Ali Samsudin et al. (2014), lack of knowledge is the main issues behind this kind of development in Malaysia. In Malaysia, the foundation for the development of the national education system rests on the National Philosophy of Education which states: "Education in Malaysia is an on-going effort dedicated to developing the potential of individuals holistically in an integrated manner so that their development, based on the belief in God, is intellectually, spiritually, emotionally and physically balanced and harmonious. Such an effort is designed to produce Malaysians who are knowledgeable, possess high moral standards, and are responsible and capable of achieving a high level of personal well-being as well as being able to contribute to the harmony and betterment of the society and the nation at large." (MOE, 2019), Existing Malaysian primary and secondary science curricula have shifted the importance from the achievement of scientific knowledge to inquiry learning.

The conservation of energy practice at the school level is important for the teachers to "promote energy literacy" in primary school (Karpudewan et al. 2012). This can be done in the learning process involving various science process skills, manipulative skills, and thinking skills. Elements of science, technology, and society, such as the relevance of science to daily lives, have been given importance. Other than that, relationships of science to the local environment and societal needs also have been encompassed in the science curriculum (Ling, 1999). As per the view of Nakai et al. (2017), the awareness among the people is important before the energy literacy to develop the energy practice. The case of Japan, it has been found that the lack of awareness between the people has reduced the effectiveness of energy literacy. The primary science curriculum provides pupils with opportunities to develop their understanding of science concepts and

principles through five fields of study. Acquisition of various skills and inculcation of attitudes and values are integrated across these fields of study. It is also important to take care of sustainability of the education before developing the energy education (Wan et al., 2018). However, these themes are not present in every year of study (Curriculum Development Center, 2013). Man is not the only one that needs energy. All living things obtain energy and use it to carry out life processes. Students can appreciate the prominence and use of energy by understanding these themes well. Additionally, it is important to develop the attitude of the people towards the use of renewable energy to solve the environment issues due to the energy consumption (Alam et al., 2016).

Furthermore, this can plant the need and importance to conserve energy as well. In the topic of energy in Malaysian primary science curriculum, students learned that energy is required to enable things to work or move. The recent development of the practice of renewable energy in the rural area is surely a significant development in the context of energy education (Borhanazad et al., 2013). Other than that, the students also were taught that some sources of energy can be depleted and most importantly the role of human in energy conservation (Curriculum Development Center, 2013). From their learning throughout this topic, the students recognise and learn that most of our energy source are derived in some way from the Sun. As the main objective of this topic, as the end product, the students will be able to infer and show concern for the need to conserve energy usage in our everyday life (Curriculum Development Center, 2013). Functional literacy is a public culture which is educated, cultivated, and sophisticated through school education to form the basis of social independence of individuals (Sato, 2003). And literacy contributes to understand and identify the issues to be solved, to decide, and to take action. It is obvious that the participation of energy-literate citizens in discussions on energy policy is expected. According to Akitsu (2009), an energy-literate individual is defined as one: 1. Knows the complete energy process from resource production to energy distribution through energy transportation, conversion, storage, and waste management. 2. comprehend the power of energy choice on economic competence, energy security, and the environment. 3. Aware of the need and efficiency of individual contributions to energy-related problem solving in an emerging sustainable society. 4. Enhances an individual's knowledge, skills, and ability to understand energy-related information or details. 5. collaborate with everyone addressing the energy linked problem solving 6. Endures suitable actions for energy saving.

Energy literacy is also described as citizenship understanding comprising the domains of cognitive, affective, and behavioural (DeWaters and Powers, 2013). Cognitive consist of knowledge, understandings, and skills. Affective is about sensitivity and attitudes. The third domain, that is, behavioural, includes intentions, involvement, and action. An energy literate person must be sensible to how personal energy-related decisions and actions can have impact on the global community. He or she must attempt to make wiser choices and show behaviour which reflect their concern for energy resource development and energy consumption (DeWaters, Powers & Graham, 2007). A residential energy literacy survey involving 1721 Dutch households, for example, indicated that 56 % of the respondents were aware of their monthly charges for energy consumption, and only approximately 60 % appropriately evaluated their investment decisions in energy efficient equipment (Brounen et al. 2012).

An energy literacy survey involving 3708 secondary students from New York State indicated that despite exhibiting a higher level of concern about energy problems, these students possessed a relatively low levels of knowledge and behavior about conserving energy (DeWaters and Powers 2011). In Taiwan, an energy literacy survey involving 2400 secondary students indicated that despite students' knowledge about energy, there was a notable discrepancy between affect and energy-saving behavior, in other words, between what people said they would do and their actual behavior (Lee et al. 2015).

In another survey, involving 276 Malaysian secondary students, it was evident that this group of students possessed a low level of energy literacy (Lay et al. 2013) despite the government's effort of introducing informal (KeTTHA 2009) and formal energy education (CDC, 2002). Therefore, Lay et al. (2013) suggested that there is a need to have a context-based curriculum that emphasizes energy literacy. Project-based learning based on local context would be a possible means to implement a context-based curriculum (Thomas 2000). Therefore, we need to prepare citizens who have an understanding of rational thinking, intellectual capabilities, creativity, and scientific ideas to nurture citizens with an awareness of the issues and problems that exist throughout the world. By these, students can make important decisions better on health, global community, environment, and social policy dimensions (Choi, Lee, Shin, Kim & Krajcik, 2011). It's not only endeavours for changes in behavioural aspects, but also for empowering citizens to take attentive decisions scientifically. Decision-making skills, practical energy-related knowledge, ethical, value judgments, and moral dimensions are correlated with energy conservation (Chen et al., 2015).

The recent development of human lifestyle is the key reason behind the importance of energy education. Due to this reason, the requirements of energy literacy have developed not only in Malaysia but in the global stage as well (Choi et al., 2011). This is the reason it's said that energy literacy must be advanced and given priority as an issue of most extreme significance when comes to current environmental risk issues (Zografakis, Menegaki, & Tsagarakis, 2008). It can change the behaviour of citizens towards a rationale utilization of energy and in improving energy literacy among themselves. This contributes students, instructors, and parents with the chance to acquaint themselves with conservative energy handicaps, energy-saving prospects, and renewable energy. Students can build up energy behaviour and mindfulness and change themselves into sustainable energy friendly citizens and consumers when they grow up (Zografakis et al., 2008).

Energy literacy is a method by which people become more acquainted with energy, such as what it involves, how to utilize and make important decisions on energy issues. It is ought to be classified according to the focused group of audience such as the students. (Oo, Abbasoglu, Dagbasi, & Garba, 2017). The concept of energy literacy can specify that actions that arise from a mixture of significant attitudes, knowledge, and intentions will be utilized to discover children's energy saving practices. (Aguirre-bielschowsky, 2013)

VI. METHODOLOGY

The research design of this study includes the description of the mixed method research (MMR). Both quantitative and qualitative approaches of data collection will be performed in this study as it employs MMR. In the quantitative study, a quasi-experimental design involving two groups which is the experimental group (EG) and control group (CG), will be used. Control group and experimental group are randomly assigned. A quasi-experimental design remains the most powerful method available for assessing the effectiveness of any kind of intervention. A pre-and post-quantitative survey will be administered before and after the treatment for both groups to determine the effect of treatment in changing scientific reasoning skills, understanding about the rate of reaction, and transformative experiences among the secondary school students. Qualitative approach which focuses on the interviews, analysis of interview data, and open-ended questions will be used to get the insights of this study. A total of 62 standard five students participated in this study. The whole of two classes from both schools were randomly appointed as experimental and control groups. A minimum sample size of 30 students is noted to be appropriate for experimental research (Gay & Airasian, 2000). As such, the participation of 30 students in the experimental group and 32 students in the control group in this study is appropriate. Besides students, two teachers from both schools were participated in this research. For the experiment group (EG) students, the teacher was given proper briefing and training for three days regarding the STEM integrated lessons that need to be conducted in the coming weeks.

VII. FINDINGS OF THE STUDY

According to the received data from the mixed method research in this study and the Energy Literacy Survey, students' energy awareness and positive attitudes are in the very high level. Students are typically aware of and accept the presence of energy challenges, are concerned about energy conservation and renewable resource use, and have apparent positive attitudes and values about energy, which is consistent with previous findings. Students with strong efficacy beliefs have the lowest percentage in the affective domain because they claim they are unable to contribute to the resolution of energy-related difficulties and accept responsibility in the same way that other capable students do.

Primary quantitative survey

Q1. What is your Gender?

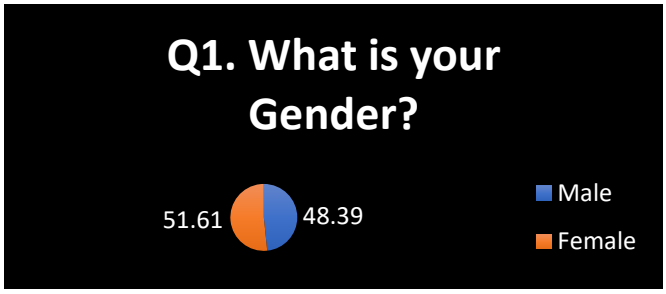

Figure 1: Age

Table 1: Age

Questions	***Options***	
Q1	Male	Female
	30	32

From the figure, it has found that 51.61% of the respondent's male participants for primary school students. Additionally, 48.39% of the respondents are female from the same primary school of this survey.

Q2: Do you think control in energy consumption is important for future development?

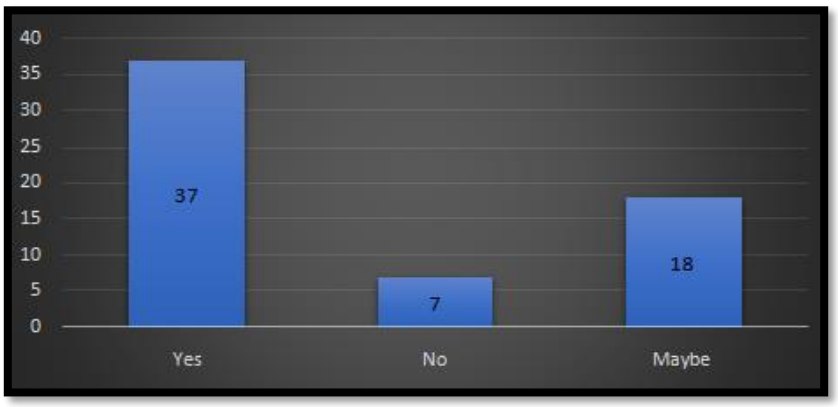

Figure 2: Energy consumption

Out of 62 people, 37 people have supported and 7 people are against this statement. However, there are 18 participants in this survey who have not provided any clear opinion.

Table 2: Topic questions

Questions	***Options***		
	Yes	No	Maybe
Q2	37	7	18
Q3	27	20	15
Q4	40	10	12

Q3: Do you believe energy education is important to reduce the misuse of energy?

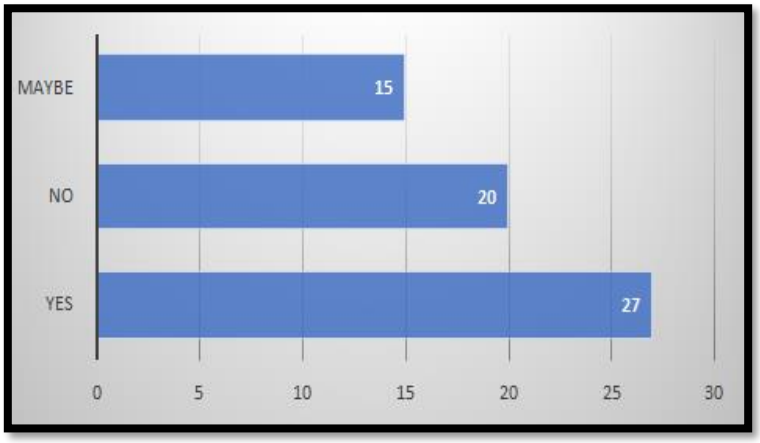

Figure 3: Energy education

As per the survey, 27 people in this survey believed in the importance of energy education and 20 people preferred other options in this case. In addition, 15 people in this case have not expressed their opinion.

Q4. Do you think it is the right time to develop energy literacy in Malaysia?

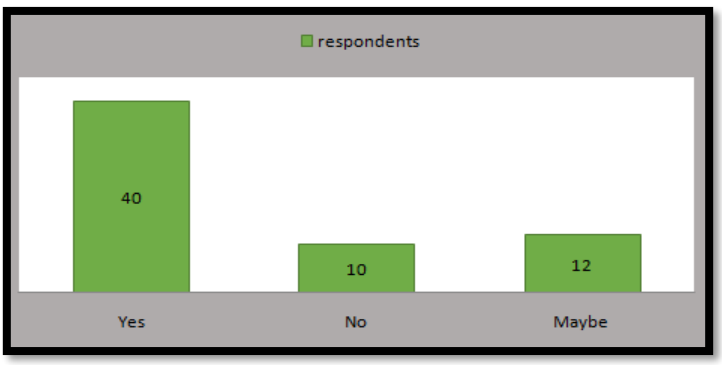

Figure 4: Development of energy literacy

From the above figure, it has been revealed that 40 people have thought this is the right time for this particular development. On the other hand, 10 people have not agreed with the statement and the rest of the people have not any idea on this statement.

Primary qualitative interview

Question 1: What are the facilities in primary education to "develop energy literacy"?

Table 3: Facilities in primary education

Teacher-1	As per the view of teacher-1 the recent development of primary education in Malaysia has developed the capacity to adapt any kind of education. However, facilities at primary level have to develop their teaching style to make this development successful.
Teacher-2	According to teacher-2 primary education has to develop more to "implement energy education" in a successful manner. In Malaysia, there are so many primary schools that do not have the facilities of basic education. However, it is a positive intent for me to make this kind of development at primary level.

Question 2: What is the importance of STEM integration in the development of energy literacy"?

Table 4: Influence of STEM integration

Teacher-1	According to teacher-1, STEM integration is always important to develop the knowledge level of the students. However, it is very difficult to make this type of integration at the primary stage of education. The management has to make their strategies clearly to make this development successful.
Teacher-2	As per teacher-2, STEM integration is useful to enhance the level of education. It is also important to increase the knowledge system and ensure the development of learning experience as well. As this integration has allowed the implementation of technology along with the proper study, therefore it is useful to secure the sustainability of the education system.

VIII. DISCUSSION

These preliminary findings suggest that increasing energy literacy in schools for students is necessary, and that research and development on energy topics should be prioritised to develop an effective energy education programme for students that focus not only on basic energy knowledge but also advanced energy knowledge, positive attitudes, and their energy-related behaviour. As per the discussion in the literature review, the importance of energy literacy is huge in recent times to protect the environment. In the interview section, teachers also mentioned the same things. However, they are concerned about the potential of the education system in the recent time for this kind of huge development. The learning method can help pupils improve their energy literacy. As per the survey, most of the respondents believe that Primary education in Malaysia is developed enough and has the capability to "provide energy education" along with the basic studies. However, from the interview of the teachers, it has been found that primary education has to develop more to adapt this change in a successful manner. Following up on this study, it recommends that students use appropriate learning to improve their energy literacy. Integrated STEM education is a teaching strategy that teachers can use. Previous research has shown that improved energy literacy success can improve students' comprehension of energy literacy.

IX. CONCLUSION

The findings demonstrate that using Integrated STEM to increase energy literacy among primary school students is successful. The 7e lesson plans on the integration of science, mathematics, and technology disciplines as applied to the solution of a real-world problem are well received by students. Energy subjects are especially helpful since they connect to a wide range of educational issues and are particularly relevant to students' daily lives. From the findings, it has been evaluated that energy literacy is important in recent times to protect the environment for the future. On the other hand, it is also important to develop the facilities to make this plan successful at the early stages of the education system. The findings indicate that the experience described in this report improved students' overall attitudes, beliefs, behaviours, knowledge, and values related to Energy Literacy.

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REFERENCES

Abrahamse, W., Steg, L., Vlek, C., &Rothengatter, T. (2005). A review of intervention studies aimed at household energy conservation. Journal of Environmental Psychology, 25 (3), 273–291. Retrieved from https://doi.org/10.1016/j.jenvp.2005.08.002

Aguirre-bielschowsky, I. (2013). Electricity Saving Behaviours and Energy Literacy of New Zealand Children.

Ajzen, I. (1991). The theory of planned behavior. Organizational Behavior and Human Decision Processes, 50(2), 179–211. Retrieved from https://doi.org/10.1016/0749-5978(91)90020-T

Alam, S. S., Nor, N. F. M., Ahmad, M., & Hashim, N. H. N. (2016). A Survey on Renewable Energy Development in Malaysia: Current Status, Problems and Prospects. Environmental and Climate Technologies, 17(1), 5–17. Retrieved from https://doi.org/10.1515/rtuect2016-0002

Barber, J. S. (2011). The theory of planned behaviour: Considering drives, proximity and dynamics. Vienna Yearbook of Population Research, 9(1), 31–35. Retrieved from https://doi.org/10.1553/populationyearbook2011s31

Baumeister, R. F., & Bushman, B. J. (2008). Social Psychology and Human Nature.

Borhanazad, H., Mekhilef, S., Saidur, R., & Boroumandjazi, G. (2013). Potential application of renewable energy for rural electrification in Malaysia. Renewable Energy, 59, 210–219. Retrieved from https://doi.org/10.1016/j.renene.2013.03.039

Boylan, C. (2008). Exploring elementary students' understanding of energy and climate change. 1(1), 1–15.
Chen, K. L., Liu, S. Y., & Chen, P. H. (2015). Assessing multidimensional energy literacy of secondary students using contextualized assessment. International Journal of Environmental and Science Education, 10(2), 201–218. Retrieved from https://doi.org/10.12973/ijese.2015.241a

Choi, K., Lee, H., Shin, N., Kim, S. W., & Krajcik, J. (2011). Re-conceptualization of scientific literacy in South Korea for the 21st century. Journal of Research in Science Teaching, 48(6), 670–697. Retrieved from https://doi.org/10.1002/tea.20424

Cialdini, R. B., & Goldstein, N. J. (2004). Social Influence: Compliance and Conformity. Annual Review of Psychology, 55(1), 591–621. Retrieved from https://doi.org/10.1146/annurev.psych.55.090902.142015

DeWaters, J. E., & Powers, S. E. (2011). Improving energy literacy among middle school youth with project-based learning pedagogies. Proceedings - Frontiers in Education Conference, FIE, 1–7. Retrieved from https://doi.org/10.1109/FIE.2011.6142961

DeWaters, J., & Powers, S. (2008). Energy literacy among middle and high school youth. 38th ASEE/IEEE Frontiers in Education Conference, T2F-6-T2F-11. Retrieved from https://doi.org/10.1109/FIE.2008.4720280

DeWaters, J., & Powers, S. (2013). Establishing measurement criteria for an energy literacy questionnaire. Journal of Environmental Education, 44(1), 38–55. Retrieved from https://doi.org/10.1080/00958964.2012.711378

DeWaters, J., Powers, S., & Graham, M. (2007). Developing an energy literacy scale. ASEE Annual Conference and Exposition, Conference Proceedings, Dassault Systems; HP; Lockheed Martin; IBM; DuPon.

Dickson, V. V., Lee, C. S., & Riegel, B. (2011). How Do Cognitive Function and Knowledge Affect Heart Failure Self-Care?. Retrieved from https://doi.org/10.1177/1558689811402355

Honey, M., Pearson, G., & Schweingruber, H. (2014). STEM Integration in K-12 Education: Status, Prospects, and an Agenda for Research Engineering; National Research Council.

Jamunah, P. (2016). The Effectiveness of Project-Based Energy Education in Promoting Secondary School Students' Energy Literacy by Jamunah A/P Ponniah. Thesis submitted in fulfilment of the requirements for the degree of Doctor of Philosophy January 2016. January.

Jennings, P., & Lund, C. (2001). Renewable energy education for sustainable development. Renewable Energy, 22(1–3), 113–118. Retrieved from https://doi.org/10.1016/S0960-1481(00)00028-8

Keirstead, J. (2006). Evaluating the applicability of integrated domestic energy consumption frameworks in the UK. Energy Policy, 34(17), 3065–3077. Retrieved from https://doi.org/10.1016/j.enpol.2005.06.004

Khoo, Y. L. C., & Treagust, D. F. (2013). Assessing secondary school students' understanding of the relevance of energy in their daily lives. 8(1), 199–215.

Mahat, H., Hashim, M., Saleh, Y., Nayan, N., & Norkhaidi, S. B. (2018). Analysis of Carbon Footprint in Terms of Electricity Consumption Practices in Primary Schools: A Case Study of Batang Padang District, Perak, Malaysia. International Journal of Academic Research in Business and Social Sciences, 7(6). Retrieved from https://doi.org/10.6007/ijarbss/v7i6/3040

Mahat, H., & Idrus, S. (2016). Education for sustainable development in Malaysia: A study of teacher and student awareness. Journal of Science and Space UKM, 12(6)(6), 77–78. Retrieved from http://journalarticle.ukm.my/10314/1/9x.geografia-siupsi-mei16-Hanifah-edam1.pdf

Mahat, H., Saleh, Y., Hashim, M., &Nayan, N. (2016). Model Development on Awareness of Education for Sustainable Schools Development in Malaysia. Indonesian Journal of Geography, 48(1), 37. Retrieved from https://doi.org/10.22146/ijg.12446

Mascone, C. F. (2013). Energy Literacy. Chemical Engineering Progress, 109(11), 3.

Michalos, A., Creech, H., McDonald, C., & Kahkle, M. H. (2009). Measuring knowledge, attitudes and behaviours towards sustainable development: Two exploratory studies. International Institute of Sustainable Development, 1 (January), 37. Retrieved from https://doi.org/http://dx.doi.org/10.1530/EDM-16-0015

Mohammed, A. H., & Wai, C. W. (2010). Energy Conservation Model for Malaysian Higher Learning Institution. International Journal of Facility Management, no.2.

Mohd Ali Samsudin, Abdul Hadi Harun, Norfarah Nordin, N., & Hasyimah Haniza, C. A.-T. (2014). The Effect of Online Project-Based Learning on Students' Attitudes towards Renewable Energy. Malaysian Journal of Distance Education, 16(2), 39–57.

Nakai, M., Okubo, T., & Kikuchi, Y. (2017). Analysis on the relationship between literacy and energy choices in Japan. 35Th Usaee/Iaee North American Conference, 1–2. Retrieved from http://www.usaee.org/usaee2017/submissions/ExtendedAbs/Nakai.pdf

O'Neill, J., Holland, A., & Light, A. (2007). Environmental values. Environmental Values, 9780203495 (May), 1–224. Retrieved from https://doi.org/10.4324/9780203495452

Oo, B., Abbasoglu, S., Dagbasi, M., & Garba, M. (2017). Evaluation of Energy Literacy among Nigerian Senior Secondary Students. 3(1), 11–18.

Pierce, J., & Paulos, E. (2010). Designing for emotional attachment to energy. Human Computer Interaction, 2010, 1–5. Retrieved from http://www.paulos.net/papers/2010/emotional_energy_DE2010.pdf

Siew, N., Amir, N., & Chong, C. (2015). The perceptions of pre-service and in-service teachers regarding a project-based STEM approach to teaching science. Springer Plus, 4(1), 8. Retrieved from https://doi.org/10.1186/2193-1801-4-8

Stohlmann, M., Moore, T., & Roehrig, G. (2012). Considerations for Teaching Integrated STEM Education. Journal of Pre-College Engineering Education Research, 2(1), 28– 34. Retrieved from https://doi.org/10.5703/1288284314653

Ting, L. S., Abdul, P., Bin, H., & Wai, C. W. (2011). Promoting Energy Conservation Behaviour: A Plausible Solution to Energy Sustainability Threats. 5, 372–376.

Toth, N., Little, L., Read, J. C., Fitton, D., & Horton, M. (2013). Understanding teen attitudes towards energy consumption. Journal of Environmental Psychology, 34, 36–44. Retrieved from https://doi.org/10.1016/j.jenvp.2012.12.001

Wan, C. Da, Sirat, M., & Razak, D. A. (2018). Education in Malaysia Towards a Developed Nation. 20. Retrieved from https://www.iseas.edu.sg/images/pdf/ISEASEWP2018-4Wan.pdf

Zografakis, N., Menegaki, A. N., & Tsagarakis, K. P. (2008). Effective education for energy efficiency. Energy Policy, 36(8), 3216–3222. Retrieved from https://doi.org/10.1016/j.enpol.2008.04.021