CLIMATE CHANGE IN THE CHEMISTRY CURRICULUM FOR SECONDARY SCHOOLS: MALAYSIAN CONTEXT

Nooraida Yakob, Zurida Hj. Ismail, Nordin Abdul Razak,
School of Educational Studies
Universiti Sains Malaysia
nooraida@usm.my

ABSTRACT
Chemistry is a study about particles and is believed as an appropriate subject to develop awareness among students to love and to care the environment. Among the aims of the Malaysian Secondary School Chemistry Curriculum is to develop a concerned, dynamic and progressive society with science and technology culture that values nature and works towards the preservation and conservation of the environment (Ministry of Education, 2005). In order to accomplish this aim, one of the issues that become very critical is environmental issues such as climate change, is suitable to be incorporated in Malaysian Chemistry Curriculum since it's related to human activities. By integrating this issue, it will help teachers to develop students' awareness on the importance of protecting our environment and assume responsibility for sustainable future. The purpose of this article is to analyse the existing Malaysian Secondary School Chemistry Curriculum and to propose new topics and activities based on the climate change which is seemed to be neglected from the curriculum by curriculum developers. The analysis is conducted by using document analysis approach. Suggestions of activities related to climate change are proposed which is interrelated with the current chemistry concept in existing curriculum.

Keywords: chemistry curriculum, climate change, environment education

INTRODUCTION

In 21st century, industry and environment had showed an adverse relationship in various aspects. Rapid industrial growth gave many negative effects on the environment such as greenhouse effect, temperature rise, effect on weather etc. The sources of these problems are human activities because their awareness and commitment towards environment are low. This situation occurred when their belief, attitude and practice were unchanged; they refuse to accept the new style of life- LIVING GREEN. They were in the comfort zone – comfortable with their current style of life. As stated by Aini, et.al. (2003), they did not have an environmental friendly life style which more focuses on using substances or materials that are harmless to the environment and humans. Therefore, the best solution to educate people and develop awareness towards the environment with this issue is through education by introducing Environmental Education (EE).

EE was not new since it has been introduced in The United States in the early of this century. According to Haskin (1999), EE was a product of co-evolutionary process within science, public awareness of environmental issues and educational ideas. Through the process of environmental education, students will develop knowledge and concern about the natural world (Haskin, 1999). As stated by Chawla (1998), EE also can encourage a sense of caring and responsibility for the earth. EE will give a good groundwork for students to appreciate the nature in which they can transform it into action.

Thus in 1998, Ministry of Malaysian Education introduces Environmental Education (EE) to all primary and secondary schools. EE was not taught as a single subject but is taught across the subject. However, the implementation of EE was not successfully. According to Sharifah and Hashimah (2006), EE was not emphasized in school curriculum and teachers were not aware of the existence of the EE Handbook (Sharifah, 2006). The guidebook does outline the proposed activities but it is not detailed enough for teachers to do the activities. As a result, teachers ignored the EE value and most of them focused on subject content

knowledge since our education are examination-oriented (Berhannudin, et.al., 2007; Toh, 2003). Because of this, students have not reached a certain level of commitment towards their environment (Komala, 2009).

When United Nation declared Decade Education for Sustainable Development (ESD) from the year 2005 to 2014, our government through Ministry of Education took this issue seriously. They put an effort to introduce the concept of ESD to all teachers and students by integrating it to all subjects across the curriculum. According to Zurida et.al (2009), based on the National Report of Malaysia on Development of education (2004), the concept used in ESD is not much different from the concept and components of EE. ESD is not a new concept; the focus is to develop and increase the awareness and commitment towards environment in young generations. However based on the research of Abdul Ghani and Aziah (2007), most teachers rarely integrate ESD concept in their teaching and learning process because they are lacked of that knowledge.

CLIMATE CHANGE AND CHEMISTRY EDUCATION

Although the integration of ESD was not really successful in Malaysia, in chemistry education, green chemistry was introduced by educators several years ago as an alternative towards ESD. As defined by Manahan (2006), Green chemistry as the practice of chemistry in a manner that maximizes its benefits while eliminating or at least greatly reducing its adverse impacts. It has a potential to solve environmental problem such as climate change. A question arises is why the emphasis given to the climate change issue. According to Feierabend, et.al. (2011), climate change is one of the key science-related issues in the political debate all over the world (Feierabend, et.al., 2011). It becomes a critical issue to be debated in the science education especially in Chemistry Education since the causes of climate change are related to the questions of chemistry and has consequences for other economics and social issues (Feierabend, et.al.,2011). Climate change is the ultimate weapon of environmental destruction. Now, climate change was not occurring naturally and growth rapidly. It affected natural and societal system. The main caused of climate change is human activities that were not environmentally friendly. Those activities involved chemical by-product that could react with the environment and do harm to the environment. We should not take the environmental condition for granted without taking any heed of the effects that we are now experiencing. The implementation of climate change issue in chemistry education is a need to produce sustainable youth.

Thus, by raising climate change issues, it can educate young generations especially students to solve and minimize the environmental issues. In addition, it also can enhance students' creative and critical thinking, problem solving capabilities and science process skills. Integration of those issues will make students are more aware and able to discuss a current environmental crisis with friends, teachers and their family members. This situation will give students an opportunity to enjoy intelligently their life safely and ethical consideration about their role in having a good environment.

As chemistry teachers, they should knowledgeable on climate change issues and act as a catalyst in highlighting this issue. They play an important role to create and develop an environmentally aware among students. What ever happened in the environment should be explained by using chemistry concepts and theorist. Therefore, chemistry teacher need some guidelines on how to integrate the climate change issues concepts in their teaching. This guideline will be different from EE handbook, which focuses more on activities related to the topic in the syllabus.

Thus, this article will review the current chemistry syllabus and suggest activities related to climate change issues. It will help teachers expand their knowledge and reveal their skills and attitudes towards climate change. Implicitly, students' awareness and commitment to environment will develop substantially.

WHERE IN THE CHEMISTRY CURRICULUM COULD WE INCORPORATE THE CLIMATE CHANGE ISSUES?

Why Chemistry curriculum? According to Parker (1989), chemistry is a study about particles and all materials in the world are made up of particles. It also provided valuable materials such as medicine, cosmetics, paint, food product, nanotechnologies, etc (Bharati, 2008). Thus, chemistry played an important role in our lives. In addition, there are five major categories in chemistry, which are related to materials, carbon-containing materials, theory and physical phenomena, chemistry of living process and identification and quantification of chemical process (Manahan, 2006). Misuse of chemistry will lead to the downside (bad) of chemistry that can harm the environment. Thus, chemistry is going to be the heart of solving the environmental issue.

In Malaysia, chemistry will be taught in Form 4 and Form 5 with the age of 16 and 17. There are four themes in Malaysian Chemistry Curriculum, which are:

1. Introduction to Chemistry
2. Matter around Us
3. Interactions between Chemistry
4. Production and Management of Manufactured Chemicals.

All themes will be taught in both forms. Each theme has its own learning areas and chemistry teachers should integrate the climate change issue in those learning areas, which have several activities. Teachers are advised to integrate those activities in their teaching process in order to increase students' awareness and commitment to the environment.

Part A: Form Four Chemistry Syllabus

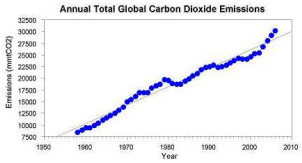
Theme	Existing Learning Areas/TOPICS	Suggested New Subtopic	Suggested Activities
Introducing Chemistry To provide an understanding of chemistry as a field of study and careers for future undertaking	**Introduction to Chemistry** Gives students ideas about : 1.common chemical substances used in daily life 2.scienctific investigation 3.scientific attitudes and good moral value in conducting scientific investigation	**Chemistry and Environment** Contribution of chemistry knowledge/substance to the environment Pros and Cons : the affects of chemistry to the environment Identify chemical substance and its effects to environment What is your contribution with your knowledge about chemistry to the sustainability	1. Students discuss and brainstorm how knowledge about chemistry affected human life and environment [Provide graphic organizer to the students – activity based – Think- pair-share] 2. Students in group discuss the affects of chemical substance (each group need to identify one chemical substance that they can get around them, stated its sources, and discuss the positive

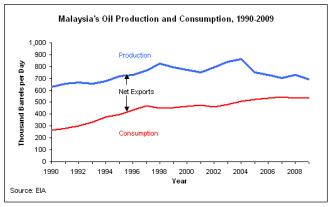
Theme	Existing Learning Areas/TOPICS	Suggested New Subtopic	Suggested Activities
			and negative effects of using this substance to human and environment – short term and long term 3. Students develop their own HAIKU- Haiku is a three-line poem with five syllables in the first line, seven in the second and five in the third. Haikus typically have nature-related themes and do not rhyme.
Matter Around Us Provide basic concepts in chemistry	**Periodic Tables of Element** Gives students ideas about : 1.element arrangement in periodic table 2.the characteristics of elements in group and period 3. electron arrangement related to elements in group and period. **Chemical Formulae and Equation** Give students an idea about : 1.number of particles, number of moles, mass number of substance, mass number of element, volume of gasses 2.emphirical and molecular formula 3. naming the substances by using IUPAC 4.chemical reaction and balance the equation **Chemical Bonds** Give students idea about : 1.naturally occurring	**Environmental Friendly and Unfriendly Elements** Students need to understand the element and its chemical and physical characteristics and how these elements can be classified into Environmental Friendly and Unfriendly Elements **Environmental Friendly and Unfriendly Compound** Pros and Cons: the used of environmentally compound in our daily life. How the Unfriendly compound effect the climate change. **Understanding about Chemical bonds (ionic and covalent bond)** Type of bonding can influence characteristics of the substance How well ionic and covalent bond trapped the heat Bonds in Ozone and other chemical substance such as tetraflouromethane, and sulphate	1. A teacher asks students to choose an element in each group and discuss its characteristics as well as making conclusion about this element. 2. Then stimulate the discussion of the substance produced when these two element react to each other. 3. Students need to identify and classify whether this new substance is environmentally friendly or not. 4. A teacher will prepare some cards with an element written on such as H, N, O, N, K, Cl or students choose by their own. [the elements can be from the syllabus or from the internet]. All cards are distributed to students. They have to find partners and form a compound. They will discuss and write the FORMULA of that compound. 5. At the end of activity, students need to categorize the compound into two categories, environmentally friendly or environmentally harmful and give some reason about their choice. 6. A role-play will take place. Three students act as ozone (A) and a group of students act as chlorine gas, tetraflouromethane, or

Theme	Existing Learning Areas/TOPICS	Suggested New Subtopic	Suggested Activities
	compounds 2. the formation ionic and covalent bond 3.The characteristics of ionic and covalent compound	compound. The characteristics may have hazardous effects on the environment	sulfate compound (B). Teachers will ask students(A) to react with students(B) and other students will write a complete equation for that reaction. 7. They also discuss the effects of ozone depletion towards human's health and environment using cause and effect graphic organizer (go) example : fishbone diagrams.
Interactions Between Chemicals To provide understanding of chemical reaction and application of chemical reaction in industries	**Electro-Chemistry** Give students idea about : 1.electrolysis process of molten compound and aqueous solutions 2,half equation at anode and cathode 3.electrolysis in industry 4.simple voltaic cell and Daniell cell 5.conducting an experiment of electrolytic cell and voltaic cell **Acids and Bases** Give students idea about : 1.characteristics and properties of acids and bases 2.differientiate the degree of dissociation for strong and weak acids and bases 3.Preparing dilute solution of acids and bases 4. analysing neutralisation 5. solving numerical problems on molarity and neutralisation 6.write a balance equation 7.conducting an experiment acid-base	**Fuel Cells** The use of fuel cell in automobile industry The effect of fuel cell towards environment The advantage and disadvantage of fuel cells Comparing the used of fuel cell and lead-acid accumulator in vehicle Why we need to change to fuel cell? What are the effects of Plumbum to the environment? **Acid Rain and its effects** In this topic, students will learn the: The benefit of acids and bases and its reaction such as neutralization to environment and people? The Formation of acid rain How this phenomenon affects environment? Ways to overcome this problem Ways to handle or relinquish acids or bases when they are no longer used.	1. After students have learned about Voltaic cells, teachers will introduce Fuel Cells to students. A teacher will guide students to build the model of fuel cells. They also discuss on how the fuel cell works. 2. They also discuss several methods how to store the used battery (chemical cells) safely. 3. Besides, a crossword puzzle is also given to students. Refer to **Appendix 1**. 4. A teacher gives a poem of acid rain and asks them to analyse it. Poem : I need sulphur dioxide I need nitrogen oxide All of these substances combined with air and I was born. I can harm your favourite plants I can attack trees by causing brown dead spot I can damage a building and statue I can do bad stuff to the environment. 5. Students will write a balanced equation: the formation of acid rain by sulphur dioxide and nitrogen dioxide.

Theme	Existing Learning Areas/TOPICS	Suggested New Subtopic	Suggested Activities
	titration to determine the end point using indicators		6. Students will discuss the effect of acid rain to the living and non-living things. 7. Role Playing – a factory will be set up in your town – Discussion in district authority either to approve the factory. Your roles as – Town councillor, teacher, scientist, environment officers etc.
Production and management of manufactured Chemicals Enable students to understand the manufacturing of chemicals for daily and social needs.	**Manufactured Substances in Industry** Gives students an idea about : 1.manufactured of sulphuric acids, ammonium and its salts 2.the importance of alloy and synthetic polymer in daily life	**The effect of nitrogen based fertilizers and synthetic polymers** **Nitrogen based fertilizer** The used of fertilizer. Type of fertilizer – organic/ synthetics/ environment. Long term effects of using nitrogen based fertilizer. Ways to reduce the used of nitrogen based fertilizer. **Bio-based Polymers** What are the bio-based polymers? How do the bio-based polymers may affect our environment?	Students will do a simple experiment on plant in two different situations: a. nitrogen-based fertilizer b. plant-based fertilizer Record the plant's growth and test the soil pH. Project for Science Club Activity : Students will do "Composting" activity. Students will do a simple experiment on 2 types of substances : a. synthetic polymers b. bio-based polymers Both substances will be planted in the soil for 4 weeks. Students will record the observation.

Part B: Form Five Chemistry Syllabus

Interactions Between Chemicals To provide understanding of chemical reaction and application of chemical reaction in industries	**Rate of Reaction** Give students ideas about : 1.observable changes to reactants 2.methods of measurements 3.factors affecting rate of reactions 4.Collision theory 5.Problem solving related to rate of reactions **Carbon Compounds**	**Climate Change** What is climate change The relationship of global warming, greenhouse effect and climate change What are the factors that will increase the rate of climate change **Global warming**	Students will discuss the rate of climate change by using an example such as : The graph of global CO_2 concentrations :  Ask students to predict the atmospheric concentrations of CO_2 in the year 2015-2020 and reasons why this situation occurred. Students also discuss the relationship between CO_2/other greenhouse gaseous and the rate of climate change.

	Give students an idea about: 1.physical and chemical properties of alkanes, alkene, alcohols, carboxylic acid, fats 2.reaction of carbon compounds 3.chemical test to differentiate the types of carbon compound 4.the existence of isomerism 5.Writing a chemical reactions **Thermo-chemistry** Give students an idea about : 1.exothermic and endothermic reactions 2.heat of reaction of different types of reactions 3.problem solving on various types of heat of reactions	What is global warming? Global warming and greenhouse effect. The effect of greenhouse gaseous on the rate of global warming How to reduce the rate of global warming **Renewable energy** Listed the sources energy in our current Discuss and brainstorming how this sources is found and its use? Are these sources can be reduced in its volume? Discuss and how it is affect our life and environment? Definition of Renewable energy and why it is important. The used of Renewable energy in Malaysia and other country. What Malaysian can learn from others? The efficient of renewable energy.	Students will write the chemical formulae of greenhouse gaseous. Students discuss the greenhouse effect and global warming. Brainstorm how does it happen by using Graphic organizer. They also discuss the cause and effects of global warming towards humans and environments by using Y-shape Graphic organizer. Students will analyse the graph : a. The relationship between oil production and oil consumption b. Predict the oil production in the year 2015  Students will discuss renewable energy in Malaysia. Students will compare and contrast the efficient of renewable and non-renewable energy by using graphic organizer.
Production and management of manufactured Chemicals Enable students to understand the manufacturing of chemicals for daily and social needs	**Chemical for Consumers** Gives students an idea about ; 1.the used of chemical substances in soap and detergent, food additive and medicine	**Petroleum-based product** What is Petroleum-based product The advantages and disadvantages of Petroleum-based product How does it affect the climate change?	Students will write a list (at least 5 items) of Petroleum-based product. By using problem-based learning, students will discuss the effect of Petroleum-based product on the environment and climate change.

CONCLUSION

Climate change is an important issue around the world. Thus, by having such activities in the chemistry curriculum, students will not only deepen their understanding on climate change effect but also will increase their awareness and commitment to the environment. By some means, this integration also can affect the teachers in improving their knowledge and awareness towards the climate change. They will also attempt to figure out an alternative way in order to sustain the environment. Teachers should make an effort to implement the message of climate change. They play an important role to educate students to love and save the environment by reducing the impact of climate change.

Education is the fundamental building block in our lives. Children are just as a blank paper and teachers are like the painters who paint the students with colourful knowledge. Every single effort in education probably helps to produce responsible generations who are more creative and dynamic in the future. Hence, by educating students with climate change concepts, they will be environment-oriented citizens and able to adapt climate change-related trends. What we hope is the teachers will integrate those proposed activities continuously as their teaching practice rather than as their work burden.

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Appendix 1 (Crossword Puzzle)

Across

1. Fuel cell is an _____ device.
4. An anode is the _____ electrode in an electrical device.
6. _____ is a chemical means in the transfer of ions from one medium to another.

Down

2. Fuel cell produces electricity from _____ on the anode site.
3. Fuel cell produces an _____ on the cathode side.
5. A cathode is the _____ electrode in an electrical device.