EXEMPLARY PRACTICES IN SEARCH FOR YOUTH SCIENCE AND MATHEMATICS RESEARCHERS (SERIES 1): 'SCIENCE ACROSS THE WORLD' (SAW) PROGRAMME

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Abstract

The advent of the digital globalization era has resulted in an increasing demand for sustainable e-learning platforms to facilitate the sharing of best practices in science/mathematics education. Science across the World (SAW) is an international education flagship programme founded in 1990 by the Association for Science Education (ASE). The main objective of this programme is to provide a forum for students, aged 12 to 17 years, to exchange facts and opinions with youths around the world through a unique series of compact resource topics on environmental and social science issues. Since the inception of SAW, SEAMEO RECSAM has been the programme coordinator for the Asia Pacific region, playing a major role in promoting the teaching and learning of science via ICT integration. Over the past two decades, RECSAM has contributed towards human resource development; to provide training opportunities as well as coordinating capacity-building activities. Recently, the Centre has embarked on promoting project-based activities (PBA) and problem-based learning (PBL) to a wider audience aimed at achieving the 'Education for All' (EFA) mission. A web-based learning portal entitled '**S**outh **E**ast **A**sia **R**egional **C**apacity-enhancement **H**ub' (SEARCH) has been developed to promote science and mathematics learning incorporating ICT, with more exchange of ideas and sharing of best practices, encompassing international cooperation via on-going e-research and capacity-enhancement activities. This article reports the first of a series of the completed and on-going SAW related activities with evidences of exemplary practices in SEARCH for youth science and mathematics researchers. Experiences from two SAW project schools will be elaborated. Educational implications and future direction will also be deliberated.

Key words: Exemplary practice, science and mathematics researchers, project-based activities (PBA)

Introduction

In the advent of globalization and the digitalized era with rapid development and changes brought about by technology especially in the area of Information and Communication Technology (ICT), increasing emphasis has been placed on promoting science/mathematics teaching pedagogies that incorporate sustainable e-learning portals and innovative

instructional technologies. The advancements of technology education via web-based learning portals allow teachers to employ various constructivist strategies that could actively engage learners' interest in science/mathematics learning. Literature has revealed that interactive e-learning initiatives have provided useful tools for effective global learning and web-based cooperative projects involving contextual problem-solving skills as reflected in project-based activities (PBA), problem-based learning (PBL), and participatory inquiry (PI). All approaches combine investigation, education and purposeful action with knowledge creation and transformation through contribution and shared learning (via blended on-line/off-line learning mode) in contrast with the control and transmission approach. Participants in the mentioned activities are capable of growth, change and creation (Briton, Collett & Cooney, 2010).

Effective and sustainable uses of e-learning platforms that are supported by innovative technological tools are important to facilitate science/mathematics education with the sharing of best practices. SEAMEO RECSAM, a regional training institution for science/mathematics education for the SEAMEO member countries and beyond, has also identified technology-enhanced learning activities supported by ICT tools as one of the important components in the centre's training programmes. An example of such initiative is the centre's role as the programme coordinator in the Asia Pacific region for 'Science across the World' (SAW), an international education flagship programme founded in 1990 by the United Kingdom's 'Association for Science Education' (ASE) to promote investigative science education via ICT integration. This article reports the first of a series of some completed and on-going e-learning activities facilitated via web-based learning portal entitled '**S**outh **E**ast **A**sia **R**egional **C**apacity-enhancement **H**ub' (**SEARCH**) with the URL address at http://www.recsam.edu.my/search/index.html. Evidences of exemplary practices in SEARCH for youth science/mathematics researchers (Ng & Nyunt, 2010) focusing on curriculum adapted from the SAW programme will be illustrated with experiences elaborated from two SAW projects in secondary schools. Educational implications and future direction will also be deliberated.

Programme Brief and Recent Updates

'Science across the World' (SAW) international flagship programme

'Science across the World' (SAW) is an international education flagship programme founded in 1990 by the Association for Science Education (ASE) under the sponsorship of British Petroleum (BP) Amoco. Since the year 2000, the SAW programme with its headquarters in the United Kingdom, has seen much development under the management of ASE in partnership with GlaxoSmithKline (GSK), one of the world's leading pharmaceutical and healthcare company. SEAMEO RECSAM is the programme coordinator for Asia Pacific region playing a major role in promoting the teaching and learning of science education via ICT integration. The official URL of SAW is http://www.scienceacross.org.

Objectives of the programme

The main objective of the programme is to provide a forum for students aged 12 to 17 years to exchange facts and opinions with young people in other countries through a unique series of compact resource topics, written in 18 languages, on environmental and social science issues. More specifically, this programme aims to:

- bring a global dimension to education by raising awareness of different perspectives, ways of life and national traditions of students in many contrasting societies;

- raise awareness of the common and contrasting ways science and technology affect society, industry and the environment;
- provide opportunities for teachers and students to develop their communication skills – especially in languages other than their native tongues;
- stimulate interest and confidence in science among young people with enhanced awareness through discussion of scientific issues that affect people's lives around the world; and
- provide a platform for schools in different countries to collaborate on a range of exciting and important projects.

International participation and implementation of SAW programme

Starting as 'Science Across Europe' (SAE) in 1990, this flexible programme has expanded to Asia Pacific (AP), Africa, America, Latin America and most recently to the Arabian Gulf and the Middle East. Currently, there are about 8,628 teachers from 149 countries registered with the programme. .The following list shows recent statistics (generated from SAW database at 09:49 GMT on 18/10/2010) of participating schools and teachers from SEAMEO member countries:

1. Brunei Darussalam *(23 schools and 47 teachers)*
2. Cambodia *(9 schools and 11 teachers)*
3. Indonesia (*115 schools and 167 teachers)*
4. Laos (*8 schools and 10 teachers)*
5. Malaysia (*268 schools and 652 teachers)*
6. Myanmar (*14 schools and 16 teachers)*
7. Philippines (*118 schools and 238 teachers)*
8. Singapore (*43 schools and 83 teachers)*
9. Thailand (*190 schools and 327 teachers)*
10. Vietnam (*20 schools and 22 teachers)*

Students who participated in the programme are collaborating on a range of mainly secondary school science topics. There are also curriculum topics which have adapted or incorporated mathematics learning and primary science education.

Programme Activities and Exemplary Cases

Teaching and Learning Tasks / Activities in the Programme

Science Across Asia Pacific (SAAP), a wing under the SAW programme, allows students to communicate with one another worldwide over a range of globally important issues. SAW provides easy to handle and easy to obtain scientific teaching materials for project work. The topics have been carefully selected to support the schools' curricula in the respective countries. This programme provides a forum generally suitable for students from the age group of 12 to 17 years. These students exchange facts and opinions with young people in other countries based on the level of knowledge and skills stipulated in the units. More often, teachers in the training colleges and secondary school science are responsible in the introduction of the project curriculum as well as the development of scientific knowledge and skills among their students.

SAW-based project work centres on the following three pillars:

1. *Individual student's exploration work*
   Each unit in the project includes an introduction to the project, with maps, data, teachers' notes, students' pages, and registration and exchange forms. The unit begins with an introduction followed by collection of information, data and opinions. The students could work on the activities suggested and the exploration work could be conducted via project/problem-based learning approaches.

2. *Compilation of the individual student's findings into one class opinion*
   A suggested topic usually takes between 3 to 6 hours to complete and this may include a homework assignment. A subsequent session is required to discuss the information received from other schools. The results of the students' investigations are combined for the whole class in order to exchange with schools from other countries.

3. *Exchanging class opinions, information and experiences with students and/or classes from all over the world*
   The information to be exchanged is usually sent by mail or fax, although an opportunity is also provided for linking schools by e-mail and websites. In order to enrich the exchange of experiences, some students send extra information about their schools, their local community and other details of general interest (SAW, 1998; Brachtl & Ng, 2003).

SEAMEO RECSAM as the SAAP project coordinator strives to encourage participation of students and teachers in the Asia Pacific Region by liaising with officers in the SAW headquarters at ASE, UK, as well as project partners and national coordinators through the Ministries of Education of participating countries in the Asia Pacific Region. Reports are also made regularly to the headquarters in UK pertaining to the various SAAP/SAW related events coordinated and conducted by SEAMEO RECSAM. A summary report on the status of participation from each country compiled from evaluation reports, verbal feedback or through email communication will also be prepared.

Over the past two decades, SEAMEO RECSAM has contributed towards human resource development; acting as a convener providing training opportunities with relevant and sophisticated resources as well as coordinating capacity-building activities and innovative workshops. SAW has published a series of compact resource topics or units on science, social science and environmental issues in up to 18 languages. The project developed an associated database in participating schools. Some of the printed and non-printed or web-based learning materials are listed below:

a. SAAP Book 1: "Drinking water" (Unit 1), "What do you eat?" (Unit 2), and "Using energy at home" (Unit 3).
b. SAAP Book 2: "The impact of global warming" (Unit 4), "Renewable energy across Asia Pacific" (Unit 5), "Tropical forests" (Unit 6) and "Domestic waste" (Unit 7).
c. SAAP Book 3: "Plants in our lives" (Unit 8), "Diseases: cause, cure and care" (Unit 9), "Acid rain over Asia Pacific" (Unit 10), "Disappearing wetlands" (Unit 11).
d. Global Units: "Chemistry in our lives", "Alternative energy" and "Biodiversity".

Teachers can register on-line at the SAW official website that is http://www.scienceacross.org/. They can also confirm registration or forward any

clarification by writing to the headquarters in the UK through mail / fax or email to the SAW director or programme manager (science@ASE.org.uk).

Impact on Students' Learning Outcomes

As stated earlier, the SAW programme was developed to bring a global dimension into science education by raising young people's awareness of different perspectives, ways of life, national traditions, attitudes and values in many contrasting societies in the global settings (SAW, 1998). However, the implementation of the project curriculum has reflected that learners' prior knowledge should be considered during the learning process. How students construct their understanding based on their learning contexts is also an important aspect to note. For example, the Science Across America (SAA) programme developed jointly by John Carroll University and BP, helps to show the relevance and universality of science in everyday life using the constructivist approach of learning as illustrated below:

> Consider the 'Drinking Water Unit'…. whereby water is not only a universal concern, but also a theme that interrelates all of the sciences. When faced with questions, such as "Where to get drinking water?" and "How pure… and safe is our water?", students draw on their knowledge of chemistry, biology, and physics to develop practical, useful answers. In their study of water, students discover information about colour, odour, pH, mineral content, bacteria count, filtration systems and chemical purification methods... they learn by doing…generate hypotheses and apply science concepts, strategies and techniques to real-life problems.
>
> (SAA, 1997)

In other words, the approach for science teaching is not only social constructivist in nature but students' values and attitudes in various learning *contexts* have also to be taken into consideration, with emphasis on their ability to investigate the interactions among science, technology, environment, and society (STES).

Another distinct feature in the SAW programme is that science could also be taught across disciplines. A *cross-disciplinary or interdisciplinary approach* involves cases where professional scientists, working mainly in one major discipline, often have to apply or refer to science ideas located in other science discipline. For example, a geologist's study of soil (Earth science) may involve studying chemicals within the soil (Chemistry) and living organisms in soil (Biology), along with gravity's effect on water moving through the soil (Physics) (Gega, 1994). Interdisciplinary approach could also be applied incorporating the teaching of various science disciplines (Biology, Physics, Chemistry) with other interrelated disciplines like mathematics, technology or environment, as illustrated in the following statements by the stakeholders :

> "*We started by analyzing water samples from our local rivers and canals. Then having visited the local waterworks, surveying peoples' attitudes to water quality seemed a natural extension. The topic 'Drinking Water' enabled students to cover a large proportion of numeracy core skills whilst maintaining a scientific basis to their work – but this is maths with a human face.*"
>
> (Teacher from U.K.. 2000)

> "*Science Across the World is a tremendous example of making science come alive for kids. The new road safety curriculum demonstrates uses of maths, science and technology in the real transportation world.*"

(Secretary, U.S. Department of Transportation in SAW, 2000)

> *"…Not only did the project provide a global awareness of issues, it promoted a link to various communities (hydro, gas, utilities, water companies). Students were motivated to learn…*"
>
> (Teacher from Trinity College School, Port Hope, Ontario, Canada in SAA, 1997)

Transformation of Classroom and School Practices by Teachers or School Leaders

Since the SAW project was introduced to Japan in the late 1990's, efforts were initiated to promote it among high school teachers. Practical researches were conducted to meet the needs of the Japanese curriculum. For example, an "Environmental Education Research Committee" was formed in 1994 in the Japan Society of Physics and Chemistry Education (JSPC) as there was a need to study the educational issue of how to teach environmental problems (Tanaka, 1997), to evaluate if SAAP/SAW fits the Japanese educational system and to explore the more useful usages (e.g. research by Niida, et al., 1997). The following is one of the positive feedbacks reported:

> "*…Science/technology education, energy/environment education, and education for globalization are the three major issues in the Japanese educational circles. Teachers have been aspiring to look for good teaching materials and programmes. Many teachers agree that the SAAP meets all these needs that have been discussed so much so often.*"
>
> (Tamura and Tanaka, 1995, p.4)

In Malaysia, a study was conducted by the regular course participants of SEAMEO RECSAM's AS-1018 course (9/2 to 19/3/2004) using the Action Research paradigm to explore how project-based activities (PBA) via ICT integration would foster students' positive attitudes towards science using SAW web-based learning curriculum on the topic "Renewable Energy". The first author was involved as the SAW regional coordinator and course supervisor to facilitate this research study that was conducted among all-male secondary school students, taught by the second author, in a boarding school. The general concerns among the researchers and the subject teachers on "the students' inert attitudes towards science which were especially manifested since the introduction of science learning in English" had been identified as the research problem that was addressed. The research was conducted on a sample of 28 students (13 to 14 year-olds) and the instruments used were the questionnaire, interviews and classroom observations. The study was considered successfully undertaken with practical significance for the researchers and stakeholders based on the findings from the qualitative analyses. When comparing the pre- and post-intervention survey results, there was evidence that indicated a slight improvement of the students' positive attitudes towards science learning when PBA was incorporated with ICT using the SAW e-learning platform. The subject teacher as well as the school administrators had shown enthusiasm and concern over the findings. They shared the same views with the researchers that there was information for them to reflect on and plan for the improvement of teaching and learning via more action research cycles in the future, in order to make their students show improvement especially in the areas of science learning (Bernadas, et al., 2004).

The success of this study spearheaded more subsequent PBAs via ICT integration where classroom practices were documented and research evidences were reported by Ng, Tan and Toh (2007), Ng, Devadason and Toh (2009) as well as Toh, Devadason and Ng (2009), to name a few [Refer also *Appendix A* for the exchange form on 'Drinking water' submitted by

the students of the second author]. Ng and Fong (2004) explored the impact of the SAW programme from the perspectives of the social constructivist and socio-cultural theoretical/conceptual frameworks which had focused on interdisciplinary and cross-curricular approaches to science learning. Adaptation of the SAW curriculum unit into PBA via values-based mathematics learning activities entitled '*Global Maths Projects*' were also elaborated by Ng, Teoh and Tan (2007) with research evidences reported by Tan, Ng, Ch'ng and Teoh (2007).

In fact, there are many other researches which had been conducted and where feedbacks were collected in relation to the development, trial, and implementation processes since the inception of the SAW programme. Experiences in trial exchanges showed that making links with students in other Asia Pacific countries has been highly motivating. The following quotations are taken from some schools which had taken part in the project:

> "*Yes, it's good fun carrying out experiments on this project. Learning from other countries' experience gives us greater understanding*."
>
> "*I have discovered the variation in the amount of energy used per household and its cost and gained a better understanding of the life style in other countries*."
>
> *"I enjoyed building a water purifier and exchanging information with other countries."*
>
> (SAAP, 1997)

Basically, most teachers concur with the curriculum introduced in the SAW programme; especially those related to the aspects of Scientific and Technological Literacy (STL), scientific information and the various pedagogical aspects, e.g. active learning, student-centred learning, problem solving, use of ICT, and so forth that the programme could bring about as reflected by the following feedback from project teachers :

> "*…I believe in including as many aspects of science literacy as I can into my biology curriculum. SAA gave my students and me an opportunity to 'see' how the topics we study are important to people all over the globe. The reality of connecting with other students and other teachers gave my lessons an added dimension – that of universality… I think the most important 'thing to try' is to include one of the units into my existing lessons, e.g. the lesson on food, nutrition and water quality…"*
>
> (Teacher from Wickliffe High School, Ohio, USA, 2000)
>
> "*In the context of this exchange of scientific information, my students get all sorts of … information about kids their own age who are studying these same science units in different parts of the world… We had created a 'Science Across' bulletin board with some materials received…, e.g. map of the world tracking global weather, seismological and other climatological activity across the globe*."
>
> (Teacher at St. John Nepomucene Catholic School in Cleveland)
>
> "*…It was a wonderful opportunity for students to engage in active learning. The project… provided a venue for student-centred networking…The project allowed a link to what the students were studying at school to their 'real life' experiences…"*
>
> (Teacher from Trinity College School, Port Hope, Ontario, Canada, 2000)

"*I loved the concept of having students research a topic and exchange data with students from around the world…. we need to have our students thinking globally, the Science Across America/World allows students to be acting globally with hands-on research … The students have gained a more relevant perspective of their own community while also learning how other students across the world are dealing with the same topics. We have both gained a wider knowledge of the subject and greater understanding of the world in which we live… I have captured the interests of my students with the added feature of exchanging with other schools/students*…"
(Teacher from Myrtle Beach High School, Myrtle Beach, South Carolina, USA, 2000)

"…We t*ry to get students to guide their own learning…with incredible ideas about collecting information, additional information to include with the exchange form, and how to solve any problems that arise. For example, we were…having problems receiving exchange forms. The students decided that if they put their information on a web site, some (not all) classrooms would be able to get theirs easily and get a feel as to what their school and culture was about. They are hoping that others will put their information on their school web page to make some exchanges easier and provide more information.*"
(Teacher from Trinity College School, Port Hope, Ontario, Canada in SAA, 1997)

Even government officials also found the programme successful in various aspects:

"*We consider that Science Across the World comes to fill up the gap of pedagogical needs we have in our educational system. The innovative methodology especially the possibility of sharing our culture with the rest of the world via Internet, are aspects that make Science Across the World an excellent tool*."
(Education Secretariat, Columbia, 2000)

"*Science Across the World in Zimbabwe brings new motivation into the learning of Science. It promotes an inquisitive and enquiring mind generally lacking through traditional teaching strategies. It also utilises locally based resources thereby making it practical and relevant to pupils*."
(Minister of Education, Sport and Culture in SAW, 2000)

More importantly, students had benefited a lot from the programme, as reflected by their feedback:

"*It's good fun and learning from experience gives us a better understanding*."
(Student from Bandung, Indonesia in SAW, 1998)

"*We didn't know what kind of energy is mostly used in other European countries, and we learned a lot and enjoyed communicating with other students*."
(Student from Slovenia in SAW, 2000)

"*The idea of Science Across the World was awesome!!!! I learned a lot of stuff from it about Canadians, and eating disorders. I compared this information with eating habits in my home country of Belarus. I think the project is really, really cool*."
(Student from Trinity College School, Port Hope, Canada, 2000).

> "*I really liked doing the 'What do you eat' unit because it taught me a lot about my health and the food I eat every day. It also taught me about some of the health problems that you can get from not eating the right foods*."
>
> (Student from Trinity College School, Port Hope, Canada, 2000)

> "*I've gotten to talk to a lot of people in schools from France, Normandy, Germany, Hawaii and other countries. I have felt a real sense of teamwork and friendship with these people although I've never met any of them – until the other day when one of the teachers I had been e-mailing was on an exchange to our school. It was really strange to meet her face-to-face but it was also quite exciting. Through Science Across I've learned more about science. The program is even more fun than I first thought*."
>
> (Student from Oak Farm Community School, Hants, England in SAA, 1997)

Implications and Lessons Learnt

It has been generally acknowledged that global issues, especially those concerning health and environment, could only be resolved by international agreement. The current concerns that affect the sustainability and healthy living of global citizens which had raised much attention for deliberation include issues like health and diseases, environmental debates and climate change, conservation of water and natural resources, just to name a few. Yet different societies have their own perspectives and priorities on matters such as water quality or energy use, and it is by understanding these differences that practical and acceptable solutions would be found.

The impact of SAW programmes on students' learning outcomes with the evidence of transformation in classroom and school practices have great implications on exemplary science/mathematics teaching and learning in the region. As an example with lessons learnt from the SAW curriculum, the unit on '*Diseases: Cause, Cure and Care*' is designed to fit in the Biology curriculum and links closely with the study of health and science. The unit contains background information on the topic to be covered, teachers' notes, student pages, maps, data, registration and information exchange forms as illustrated by Ng and Fong (2004). The aims of this unit are:

- To increase students' awareness of the importance of lifestyles and good health
- To compare aspects of health care and health awareness in different countries
- To increase students' awareness of common diseases including infection and diseases caused by unhealthy lifestyles.

A recent initiative by a group of girls in an urban secondary school, facilitated by the third author who was their project teacher, completed the SAW curriculum topic on '*Climate Change*' and got into the limelight for this region with their international on-line exchange. [Refer *Appendix B* for an example of exchange form on 'Climate Change' for their participation in this unit]. The participation of the mentioned female students was spearheaded by the third author who had attended a SAW training workshop which was organized by the first author during a pre-Conference on Science and Mathematics Education (CoSMEd) in 2007. The third author then introduced the SAW programme to the first group of students in her school in 2008. In the year 2009, the third author attended another SAW workshop which was organized by the second author. During the workshop, additional input on Action Research was given by the first author, with support of an ASE consultant from UK. Subsequently, under the guidance of the third author, two project teams were formed to explore issues on 'Climate Change' (Boey, 2010a). A sharing of best practices in SAW in

relation to 'Blue Ocean' strategy at a recent national master teachers' conference received overwhelming response from the participants (Boey, 2010b). The following objectives had been identified for the SAW project in this unit:

- To increase knowledge and awareness on the possible impacts of climate change in their locality, region or country;
- To develop research skills in exploring the actions taken where they live to deal with the effects of climate change;
- To enhance students' scientific skills in discussing the ways that people as individuals or as part of society are responding to the issues.

The active participation and high quality findings reported by the girls in the exchange form(s) received due recognition when the school emerged as the highest ranked project school in Malaysia and the Asia Pacific region since April 2010 (for the third quarter of the year 2010) and excelled among the top participating schools in the world. The records of their on-line exchange activities can be viewed at the SAW portal and the 'Magnificent Advancement of Young Scientists' (MAAYS) e-research portal with URL: http://forum.maays.net/viewtopic.php?f=29&t=238.

Conclusion and Future Direction

Increasing emphasis on the science curriculum to promote the teaching of scientific knowledge and how science works through the development of key skills in the 21st century have been advocated by many countries. Apart from scientific, higher order thinking and social skills such as communication, critical/creative thinking, enquiry/research, reasoning and collaborative skills as elaborated in this article, the SAW programme also provides an excellent platform where students can develop knowledge and skills in ICT-based learning. In recent years, ICT has been identified as one of the effective tools to extend the knowledge of learners through extensive research and interactive activities over the Internet. Nonetheless, students should also be allowed to gain confidence in trying out new ideas in a variety of contexts using diverse strategies integrating ICT. Thus in this technologically advanced era, a supportive learning environment with pedagogically enriched teaching strategies integrating ICT is the most appealing contribution for educators who wish to incorporate the e-learning portals (SAW programme, for instance) in science and mathematics education.

This paper outlines the major activities of the SAW programme with evidences from both international and local exemplary practices in SEARCH for young science/mathematics researchers focusing on curriculum adapted from the SAW programme that was facilitated via an on-line learning hub. Two exchange forms completed by the secondary male and female students who had participated in PBAs via the SAW e-learning portal in two local schools (between the periods of 2005 to 2010) have also been illustrated. The interactive features with excellent support provided in the SAW database allowed the students to work at their own pace to complete the exchange form within the scheduled timeframe. Project teachers had acted as facilitators and provided guidance to promote the students' thinking skills and enabled them to conduct independent studies. Hence, this article reveals the feasibility of a blended mode of learning towards building networks for knowledge-exchange and peer learning in science and mathematics education in the region and beyond (Azian, Devadason, Ng & Wahyudi, 2010). More research evidence will be reported in the subsequent series to illustrate how science inquiry-based activities, scientific and higher order

thinking skills could be enhanced via e-learning activities supported by highly interactive digital learning environments.

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Appendix A

Example of Exchange Form for SAW Unit "Drinking Water"

Science Across the World

Drinking Water

TO:

Date	20/9/2005
Teacher's name	SS-1100 participants
School	RECSAM school Malaysia
Address	Jalan Sultan Azlan Shah, 11700, Penang, Malaysia.
Phone numbers (inc. dialling code)	Telephone: 604-6583266 Fax: 604-6572541
E-mail address	recsamss@yahoo.com
School website address	http://www.recsam.edu.my

We understand that your class is studying *Drinking Water*. We would like to exchange information about water resources and analysis in relation to your health. We enclose the opinions of our class with this exchange form.

We look forward to hearing from your class. Please reply.

FROM:

Teacher's name	Ms Linda Toh
School	SMKA Al-Mashoor(L)
Address	Jalan Air Itam, 10460, Penang.
Phone numbers (inc. dialling code)	Telephone: 604-2296790 Fax: 604-2291503
E-mail address	smkaalmashoor@yahoo.com
School website address	

Water Resources

1. a) The main water resources in our country or region are:

   dam, reservoirs, rivers [*ideally with class 1 of water quality index (WQI) or at least class 3 which must be treated before being used as drinking water. However, even with class 1 WQI, people should ensure that the drinking water is collected from the centre part of the fast moving river as most of the time, the water collected by the side of the river may be contaminated with urines from animals.*

   Refer: http://www.pca.state.mn.us/water/standards/index.html

   Note : We have conducted a study to "monitor the river water quality" with a group of Aceh teachers from RECSAM and a Senior Programme Coordinator from Socio-Economic and Environmental Research Institute (SERI) who had visited our school on 13/9/2005. We have learnt how to monitor the quality of water using various reagents or chemical agents for use in chemical reactions. Please find attached Appendix for our report of findings.]

b) Where we live, we use these water resources: dam, reservoirs, wells, rivers

2. a) Where we live, it rains at these times of year:

   Throughout the year, but more often in April and October, with the occurrence of the annual southwest (April to October) and northeast (October to February) monsoons.

   b) In a year, our total rainfall or the average rate of annual rainfall is quite high, i.e. about 25 000 mm (250cm or 100 inches)

   Malaysia enjoys the tropical climate with plenty of sunshine and rainfall throughout the year. Temperatures typically range from 70 to 90°F (22 to 33°C) and cooler in the highlands. Much of the rainfall is concentrated in the late afternoons and humidity is high throughout the year.

3. a) In our region, the situation about water shortage is:

   Where we live, there is no water shortage at the moment. However, during the dry months (Jan-Mar), water in the dams is usually greatly reduced. It is predicted that in year 2010, Penang is expected to have insufficient water [*Reference:* Research by Socio-Economic Research Institution (SERI), Penang].

   b) This is how often our water is rationed or limited:

   Very rarely water is rationed. During repair of roads, pipes, etc., notices will normally be sent to houses for the temporary cut of water supply.

4. Examples of the ways in which people re-use water are:

   - Use rainwater to wash car
   - Recycle water from washing to water plants, flush toilets, clean five-foot way/corridors/drains, etc.
   - Recycle water from washing rice, fish or meat to water plants (which is believed to act as fertilizer including urine).

5. a) Our drinking water comes from:

   ☒ A tap connected to the mains water supply ☐ A river
   ☒ Bottles of mineral water from shops ☐ A lake
   ☐ A spring ☐ A rain water tank
   ☐ A well ☐ Others: rainfall, our school and house.

   b) The places where livestock drink are: In town, domestic pets/poultry drink tap water.

   In the countryside, the farm animals or household poultry drink water from the wells, rivers and tap water as well. People living in the jungles may drink water from various sources, but they should be aware of the health and safety aspects of the drinking water. For example, the water collected from 'monkey-up' *(Nepenthes)* consists of digestive juices which may be harmful for health, so should not be considered as the priority for drinking.

6. The estimated amount of water used in a home is: 836 litres a day.
   (26,080 litres/ 30 days for June 2005)
   about between 200 to 1,000 litres a day
   about 1.5

7. a) We estimate that a single student drinks _____ litres a day of tap water (including in coffee, tea and other drinks made with tap water.

   b) We estimate that a single student drinks _____ litres a day of bottled water.
   about 1 litre
   (1 bottle is about 600 ml)

Water Analysis

8. a) The pH of our drinking water at school is (Group 4): 8.22
   The pH of our drinking water at Tanjung Tokong is: 7.41
   The pH of our drinking water at Bayan Baru is: 7.41
   The pH of our drinking water at Ayer Itam is: 8.07
   The pH of our drinking water at Caunter Hall is: 7.24
   The pH of our drinking water at Bukit Mertajam is: 7.50

   b) The concentrations of impurities are:

   lead ions, Pb^{2+} : <0.05 mol/L or <50 µg per litre
   nitrate ions, NO_3^-: <10 mg/L or < 10 000 µg per litre
   pesticides : between<0.000003 to 0.02 mg per litre

   The following table is the information obtained from Chemistry/Health Department regarding the *"Recommended raw water quality : criteria and frequency of monitoring"* (*Engineering Services Division, Ministry of Health Malaysia*)

No	Parameters	Column I Acceptable value mg/l *(unless otherwise stated)*	Column II Frequency to be monitored Surface	Ground	Indirect impounding	Column III Source of Reference
	Group I					
1	Total Coliform	5,000 MPN/100ml	W	M	M	WHO1
2	Turbidity	1,000 NTU	W	M	M	WHO2
3	Colour	300 TCU	W	M	M	WHO1
4	pH	5.5-9.0	W	M	M	MAL
	Group II					
7	Nitrate Ions	10	M	Y/4	Y/4	MAL
	Group III					
6	Lead	0.05	M	Y/4	Y/4	MAL
	Group IV					
	Organo Chlorine Pesticides					
1	Aldrin/Dieldrin	0.00003	Y/4	Y/4	Y/4	MAL
2	DDT	0.002	Y/4	Y/4	Y/4	MAL
3	Heptachlor & Heptachlor Epoxide	0.00003	Y/4	Y/4	Y/4	MAL
4	Methoxychlor	0.02	Y/4	Y/4	Y/4	MAL
	Non-Organo Chlorine Pesticides					
5	Hexachloro-benze	0.001	WN	Y/4	Y/4	MAL
6	Lindane	0.002	Y/4	Y/4	Y/4	MAL
7	Chlordane	0.0002	Y/4	Y/4	Y/4	MAL
	Herbicides					
8	2,4-D (Dichloro-phenoxyacetic Acid)	0.03	WN	Y/4	Y/4	MAL

W/M/Y : Indicates parameters to be monitored at least once a week/ month/ year.

Y/4 : Indicates parameters to be monitored at least once in 3 months.

WHO1 : Refers to WHO International Standards for Drinking Water 1963.

WHO2 : Refers to WHO Guidelines for Drinking Water Quality Vol.1 & 2 1984.

MAL : Refers to value adapted for Malaysian conditions.

Notes:
Collection of samples of both raw and treated water for examination for toxic substances should be carried out more frequently if values above the acceptable values are known to be present in the source of supply, or where such potential pollution exists.

9. The hardness of the water is: ☒ low *(about 33mg/l)*
   ☐ medium
   ☐ high

   "Hardness" (*kelitan*) is the amount of dissolved calcium and magnesium in water.

10. The number of coliform bacteria is 0 or less than 1 per 100ml in our local water supply.

    By right it should be 0 per 100 ml to be safe for drinking. But raw water which is not safe to drink will normally have coliform bacteria. The test for coliform bacteria will take about 24 to 48 hours, or 3 to 5 days, and was normally conducted in the Chemistry/Health Department next to the General Hospital. The following are the pictures illustrating that water contaminated with coliform bacteria will turn the colour of indicator from purple to cloudy greenish/purplish things with gas floating on top of the solution (*traditional technique*) OR showing the reddish or purplish patches in the sampling culture which was put inside and oven with 37°C (to reactivate the bacteria) before the testing for about a day (*new technique*):

11. Impurities that exceed the EU guide level for drinking water are:

    N/A. Our drinking water at school and housing areas contains no substance exceeding the Ministry of Health (MOH) standards which are in accordance to World Health Organization (WHO). It was proved to be safe to drink after water testing was done in Water Treatment Plant, Botanical Garden, Penang.

12. In our country the drinking water guide levels are:

    ☐ the same as the EU
    ☒ the same as the WHO or Ministry of Health (MOH)

    They differ from the EU or WHO in these ways:
    Parameter Standards Recommended by PBAPP (Penang Water Treatment Plant) Guidelines (Group 4 and 5 reports)

Parameter	PBAPP Standards	MOH Standards	Drinking water collected from SMKA Al-Mashoor(L)
Turbidity - TPO	Less than 1.0 NTU	<5	3.82 NTU (Tanjung Tokong) 1.13 NTU (Tea garden REC)
- Distribution	Less than 5.0 NTU	<5	-
Chlorine Residues - TPO	1.5-2.5 ppm	>0.2 ppm	1.0 ppm (Group 6)
- Distribution	Not less than 0.2 ppm	>0.2 ppm	-
pH	6.5-9.0	6.5-9.0	[see 6(a)above] ppm
Aluminium	Less than 0.2	0.2 ppm	unable to do as it takes 30mins
Iron	Less than 0.3	0.3 ppm	0.04 ppm (Group 4) 0.09 ppm (Group 6) 0.13 ppm (sample)
Fluoride	0.4-0.8 ppm	0.4-0.8 ppm	0.29 ppm
Colour	15 TCU	15 TCU	17 PTCO ("different unit)

Key NTU: Nephelometric Turbidity Unit
ppm: part per million
PTCO: Platinum Cobalt

Apart from collecting data as presented above during our visit to Water Treatment Plant (WTP or Perbadanan Bekalan Air Pulau Pinang, PBAPP) (27/7/05), we have also obtained other information as below :

* The Vision of PBA (Group 6 report) : Meeting all your water supply needs

* The Mission : PBAPP will be the leading organization in water expectations

* History of PBA : It was built on 1892 with 232 feet, depth 32, tall 300m reconstructed in 1950 by J Mac Ritchie, A.M.I.C.E.

* There are two sedimentation tanks, total area of sedimentation tanks (excluding inlet and outlet channel) 390m².

* There are three filter beds, with area of each filter bed 31m² and total area of sedimentation filter beds 93m².

* Floculation channel → Chemical Dosing (e.g. Chlorine) → Sedimentation tank → Filter bed → Reservoir

* The design (maximum) plant capacity is 18,200 m³/day or 18.2 million litres of water a day and the rate of filtration is 125 l/m²/min. The number of reservoirs/ capacity/ level is 1 no./ 22,000 m³ TWL: 70.87 m, FL: 61.72 m

* The raw water source is Sungai Air Terjun which flows downhill from Penang Hill. The delivery pressure is 70.87 m. The river "delivers" water from the verdant and refreshing Waterfall and Highlands Catchment Areas.

* In Chemical Dosing Room (Group 6 report),
- The following precautions must be taken : Wear ear protection, safety helmets, mask, glove, boots
- Ensure that Poly, Lime, Chlorine and Alum are below 1.0 ppm

We have also made some prior reading before our visit as discussed below.

* The following is our understanding of the sources of natural water and reasons for water purification (Group 2 report) :

(a) Sources of natural water

The sources of natural water are waterfall, river, ice and snow, lake, well, pond, rain, oasis, sea, spring
There is more water than any other liquid on the earth surface. About 75% of the earth surface is covered by water, mainly by oceans. But only about 3% of the earth's water is fresh water and can be drunk. Some parts of the earth are covered by ice and snow. These include high mountains and the areas near the poles. Water is also found in the atmosphere as water vapour. Tropical rain forests have a damp atmosphere.

(b) Reasons for water purification

The water from the environment such as from the lake, the river, and the sea is usually unsuitable for drinking. It has many contents such as:

- floating debris - suspended sediments
- dissolved substance (some may be harmful)
- micro-organisms - excess salt (sea water)

Water has to be purified before it can be used as drinking water. Among the reasons for purifying water are :

- to make the water clear, tasteless and odourless
- to remove floating debris (e.g. leaves and dirt)
- to remove suspended sediments (e.g. mud, algae)
- to kill micro-organisms (bacteria)
- to remove harmful dissolved substances (e.g. lead and mercury compound)
- to add important minerals which are required for good health (e.g. sodium silico fluoride)

* The following is our understanding of the definition and the summary for the methods of water purification (Group 5 report) :

- The process in which unwanted substances in water are removed is called water purification. There are various types of water purification such as sedimentation, filtration, boiling, chlorination and distillation.

(a) Sedimentation :

- A mixture of water and heavy insoluble solids will separate after a while. The solids will settle or sink to the bottom as sediments due to gravity.

(b) Filtration :

- Makes use of a filter where liquids such as water and solutions pass through while insoluble solids are separated. The liquid that passes through the filter is called the filtrate.

(c) Boiling :

- Kill most, if not all, micro-organisms present in the water. Tap water may be used for drinking but it is always safe to boil tap water.

(d) Distillation :

- When a mixture of water and impurities is heated until it boils, only the water changes into steam while the impurities are left behind. The steam is then cooled and condensed to produce pure water.

(e) Chlorination and Ozone :

- Chlorine is a gas which can kill micro-organisms. Chlorine in water will not cause harm if the correct amount of chlorine is used.
- Ozone is another gas that can kill micro-organisms in water. It is now used in swimming pools to replace chlorine, as it does not have a strong smell or a bleaching effect like chlorine.

We have also studied the labels of the mineral water bottles sold in the market. The following table presents the mineral content of the most widely used mineral water.

Water and Health

13. Our main water supply is: ☒ safe to drink
❑ not safe to drink

We know this because:

We have visited out local Water Treatment Plant (WTP) and the officer had tested the drinking water we brought and performed the water analysis. We were also told that WTP had conducted regular monitoring of the quality of water (as required by the Chemistry/Health Department attached to the local General Hospital) to ensure that our water supply is safe to drink. We drink tap water everyday and we are in good health so far.

14. Before we drink water from our main water supply we:

❑ do not treat it ☒ filter it (sometimes)
❑ leave it to stand ☒ boil it
❑ treat it chemically ☒ it comes treated
❑ other : Sometimes we leave the tap to flow for a while as the water looked cloudy or dirty when it started to flow from the tap.

Types of mineral water	pH	Cations (mg/L)						Anions (mg/L)						Nutrition Facts
		Ca	Fe	K	Mg	Mn	Na	CO_3	Cl	F	HCO_3	$HSIO_3$	SO_4	
P	-	Reverse Osmosis						No info given						-
Q	7.2	12	-	3.5	1.6	-	6	-	<1	-	62	46	<3	TDS 135
R	-	0% daily value (Percent Daily Values are based on a 2,000 calorie diet)						0%	0%	0%	0%	0% silica	0%	Serving size 240ml
S	-	0%	0%	0%	0%	0%	0%	0% daily value (Percent Daily Values are based on a 2,000 calorie diet)						Serving size 500ml
T	7.4	25	-	2	1	-	4	-	10	<1	134	-	1	TDS 125 mg/L
U (*Source : Underground water*)	7.4	12	-	3.5	1.6	-	6	-	<1	-	62	46	<3	TDS 135 (*50.7 fl.oz, 1500ml*)
V	-	Super purified + Ozone + Ultra Violet						No info given						-

Types of mineral water	pH	Total dissolve (< 8mg/l)						Nutrition facts (Serving size 500 ml)					
		Total organic matter	Oil and greese	Chlorine (Cl^-)	Lead (Plo)	Coliform	E. coli	Calories	% Daily Value	Total fat 0g	Sodium 0mg (Na)	Total COH 0g	Protein 0g
W	6.6-7.2	ND	ND	ND	ND	Absent	Absent	0	0% (Percent Daily Values are based on a 2,000 calorie diet)	0%	0%	0%	

Note : TDS = Total Dissolved Solid (*Jumlah pepejal yang terlarut*). ND = Not Detected

15. The statement which best describes what people in our community know about the quality of their drink water is:

☒ They do not question the quality of their drinking water.

❑ They are aware that drinking water contains impurities, but have no idea what they are.

❑ They are aware that drinking water contains impurities and can name at least one of them.

❑ They are aware that drinking water contains dissolved substances and can name several of them and their possible effects on health.

16. a) People are particularly worried about these dissolved substances or micro-organisms in drinking water:

Most people think that the tap water has bacteria or microorganisms and dissolved substances. However, they are not too worried about any dissolved substances as they think our drinking water is safe to drink. As long as they filter and boil the water before consumption, it is considered safe to drink.

b) commonly found examples of water-borne diseases which affect people in our country are :

encephalitis, malaria, cholera, diarrhoea, yellow fever, malaria, JE&Nipah virus, river blindness (onchocerciasis), vomiting schistosomiasis (or bilharzias), hepatitis, dysentery, stones in the kidney, etc.

Appendix B

Example of Exchange Form for SAW Unit "Climate Change"

Climate Change in Penang, Malaysia

First of all, let us introduce ourselves. We are from the Sri Mutiara Secondary School which is located in Penang, Malaysia. Well, thanks a lot for your willingness to exchange the information about the climate change of your state with us. We really appreciate it.

Penang is a state in Malaysia, located on the northwest coast of Peninsular Malaysia in the Straits of Malacca. Penang is a pleasant mix of warm, sunny days and occasional cooling rain storms. October through November being the wettest months generally. It enjoys a tropical climate, with rains from the annual southwest (May to September) and northeast (November to March) monsoons. The average rainfall is 2670 mm throughout the year. The humidity is usually high with temperatures averaging between 23°C to 32°C. As such, there are no recognizable hot or cold season.

However, the temperature in Penang has risen compared to 5 decades back. This is due to the activities in the name of development in Penang. We can see that climate change in Penang has an adverse impact on human health and survival including weather-related mortality, infectious diseases and air-quality respiratory diseases. Besides that, more floods have also hit Penang. Although Penang does not experience serious natural disasters such as hurricanes, floods in itself had brought much hardship to the residents. As the temperature in Penang ascends, the air pressure will descend and this causes the wind from a location which has high air pressure to blow the clouds to Penang. Thus, more rains will occur and floods occur when water overflows from the Pinang River which is made worse by rubbish.

P. Ramlee Road Area (adjacent to Pinang River)

Houses next to Pinang River

P. Ramlee Road

The water barely entering the ground floor apartment unit

Han Chiang Road

The improvement in the economy and lifestyle of Malaysians have resulted in an increase in the demand of transportation. Transportation in Malaysia can be categorized into three major groups – air transportation, land transportation and maritime transportation. Petroleum, also known as liquid fuel is needed in the transportion sector. Burning whatever fuel produces heat. The burning of huge quantities of fuel exhausts CO_2 and NO_2. These gasses, also known as greenhouse gases, contribute to the heating up of the atmosphere. In the other words, this causes the temperature to rise.

Methane gas, which can be found in dumping sites, is flammable. It causes the accidental burning in the dump sites which then increases the amount of CO_2 and warms up the surroundings. Open burning is commonly seen too. This is the work of irresponsible people who are not aware of the serious consequences. The heat produced will be dissipated into the surroundings. Eventually, the atmosphere will lose its coolness soon.

Penang is undergoing urbanization due to population increases. The opening of land for commercial or residential use will destroy the flora and fauna of tropical rainforest. Forests or trees gives out oxygen and can cut down the quantity of carbon dioxide through the process photosynthesis. Without trees, it would lead to a warmer microclimate in urban areas.

WWF-Malaysia is a national conservation trust that currently runs more than 75 projects covering a diverse range of environmental protection and nature conservation projects in Malaysia. WWF stands for World Wide Fund for nature. It was formerly known as the World Wildlife Fund but adopted its current name to show that it also works on other environmental issues, and not just wildlife.

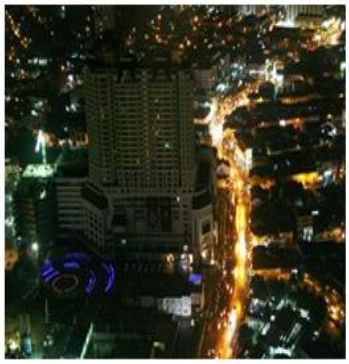
WWF

The logo of WWF

In order to cut down the emissions of the greenhouse gases that cause global warming, many steps have been taken by WWF to make our locality free from pollution and contamination. One of it was the Earth Hour campaign. Penang joined the rest of the world to flick the switch for Earth Hour on 28th March 2009 from 8.30pm to 9.30pm.

Earth Hour

Part of Penang turned dark to help Mother Nature. On 28th of March 2009, Penangites were urged to participate in "Earth Hour," to raise awareness regarding climate change and global warming. Earth Hour – the worldwide movement to make a change against global warming by a simple action of switching off the lights for an hour. And this year, Penang was a part of that global drive. The year 2009 marked 28th March as 'the night that will go down in history', the one night, when lights of millions of homes and businesses were switched off in over 74 countries and territories, from 8.30pm till 9.30pm as a call for action to be taken against global warming.



Penang Times Square

Starbucks Coffee Shop in New World Park

New World Park

Gurney Drive Food Court

Below is a list of simple steps that people can consider to reduce their energy consumption.

1. Switch off unused lights
2. Switch off unused appliances and put computers on standby mode
3. Reduce use of hot water
4. Switch off the air-conditioner when you are not in the room
5. Use shopping bags rather than plastic bags. Plastic is a petroleum-based product. That means using fewer bags helps reduce our use of fossil fuels and helps reduce global warming.

Beside that, many steps were taken by the Penang government to reduce the amount of rubbish thrown in Penang. For example, "No Plastic Bags Day". The Penang state government declared every Monday a "No Plastic Day" for Penang beginning on 1July 2009. Following consultation and dialogues with hypermarkets and supermarkets and mini-markets, plastic manufacturers and NGOs, the ban on using plastic bags on every Monday marks the serious commitment towards reducing the use of plastic bags. As the first state in Malaysia to adopt such a measure, Penang state government hopes that this environmentally-friendly approach will assist Penang achieve its goal of becoming a green state.

Plastics bags are cheap and useful, when they are given away free, the excessive use and injudicious dumping of plastic bags has turned an otherwise useful product into something that is polluting our environment. In order to encourage the consumers to bring their own bags and reduce their dependency on the plastic bags, consumers will be charged at 20 cents per bag on the "No Plastic Bag Day" at the check-out counters in shopping complexes. Proceeds collected will be donated to the Hardcore Poverty Programme of the state. Collection boxes were prepared at the check-out counters for this good purpose. This is indeed a big step for all Penangites to celebrate United Nations World Environment Day 2009.

Penang generates about 1,500 - 1,600 tons of solid waste per day, which means that Penangite generates about 1 kg of solid waste per person per day. In year 2007, the local council, MPPP and MPSP spent RM57.6 million in solid waste management. This figure accounts for 30% of the total income generated by the local government.

Our own survey of 6 major groups of super/ hypermarkets in Penang also shows that as much as 25.2 million pieces of plastics bags or 2.5 million pieces monthly have been distributed in 2008 alone. This does not take into account the other millions of plastic bags used by other retailers, hawkers and other businesses. Where do all these plastic bags end up?

According to a survey conducted by D.Playground Events for the state government, in Penang Island, 74.86% out of 1500 interviewees think that plastic bags create huge environmental problem, and 53% of them think that the government should ban the use of plastic bags. This survey will be extended to Seberang Perai soon.

We hope that by reducing the excessive use of plastic bags and through the promotion of the 3Rs (Reduce, Reuse, and Recycling), we can eventually cut down the expenditure spent on the solid waste management.

In order to overcome the problem of air pollution which aids climate change, Rapid Penang, a government-owned company was set up to operate bus services to improve the transportation in Penang. Rapid Penang began operations since 31 July 2007.

Furthermore, in conjunction with the theme of World Environment Day 2009: Your Planet Needs You! UNite to Combat Climate Change, the Penang government launched a special additional webpage in the Penang Web Portal "About Climate Change". The creation of this webpage demonstrates that the state government is serious about climate change issues. Activities like tree-planting programmes and river cleaning through EM mudballs had been organised.

In the webpage, there is an introduction to climate change, greenhouse gases and 20 tips for every Penangite to tackle climate change. The government hopes that by creating an awareness of the consequences of Climate Change among Penangites (website: http://climatechange.penang.gov.my), Penangites will be able to work together towards transforming Penang into an international city-state that is the location of choice for investors, destination of choice for tourists and habitat of choice for Malaysians desiring sustainable living.

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