TEACHER EDUCATION: LINKING SCIENCE LEARNING TO EVERYDAY LIFE AND SOCIETAL NEEDS

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Abstract

Teacher education refers to the procedure of equipping teachers with knowledge and skills required in order to perform their tasks effectively in teaching and learning. This paper reports on teacher education courses conducted in SEAMEO RECSAM with reference to the selected topics that link science learning to students' everyday life and the needs of the society, as well as how well the teachers have adopted the knowledge, skills and values to apply in their teaching career. Twenty teachers from the South East Asian countries attended a four-week course organised by SEAMEO RECSAM in Penang, Malaysia. The teachers were from Brunei, Cambodia, Indonesia, Laos PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam. The pre-test results showed that the teachers' scores on their understanding on the designed topics such as 'Education for Sustainable Development (ESD), Scientific & Technological Literacy (STL) and Socio-scientific issues (SSI)' were less than 3 points from 5 points Likert Scale. Many of them claimed that they often did not include the topics that link science to everyday life and the needs of the society; besides the ones that are stated in the curriculum. Following the four-week course, the post-test indicated better results in which the scores of their levels of perception on almost all the topics were more than 3 points on the Likert Scale. This shows that the topics selected for the courses have enhanced the teachers' knowledge and understanding; as well as their awareness on the needs to incorporate these topics in science teaching for sustainable development. The teachers' attitude and perceptions about the topics, as well as their preparedness to incorporate the topics designed in the course are also presented in this paper with discussions on follow-up activities.

Keywords: Teacher education; Education for sustainable development; Scientific and technological literacy; Linking science learning

Introduction

Teacher education is a global concern in professionalism that needs to be understood properly as it is one of the ingredients for successful Continuing Professional Development (CPD) in the teaching field. It is a continuous process for the preparation of competent and excellent

teachers to face challenges of the dynamic society and the 21st century learning environment. According to Kumar and Parveen (2013), 'teacher education' refers to "the policies and procedures designed to equip prospective teachers with the knowledge, attitudes, behaviours and skills they require to perform their tasks effectively in the classroom" (p. 8). Teacher education encompasses teaching skills, sound pedagogical theory and professional skills.

Teaching skills would include the ability to use different techniques, approaches and strategies that would help the teachers to plan and impart instruction, provide appropriate reinforcement and conduct effective assessment. It includes effective classroom management skills, preparation and use of instructional materials as well as communication skills. Pedagogical theory includes the philosophical, sociological and psychological considerations that would enable the teachers to have a sound basis for practising the teaching skills in the classroom. The theory is stage specific and is based on the needs as well as requirements that are the characteristics of that stage.

Professional skills include the techniques, strategies and approaches that would help teachers to grow in the profession and also work towards the growth of the profession. It includes soft skills, counselling skills, interpersonal skills, computer skills, information retrieving and management skills, as well as above all, lifelong learning skills. For excellent teachers in science, they have to be scientifically literate, expert in hands-on activities, as well as always be prepared to adapt to new changes and development. How the science teachers are able to relate the science teaching such as the concepts and theories in science to students' everyday life is very crucial to ensure the sustainability of the society as well as the environment. Teachers have limited time to participate in the courses, workshops or seminars due to the workload and the increasing demands in the profession. However, as the science and technology are advancing rapidly, teachers especially in science field need to be at par with such development and be aware of the current trends with the ability to link science to everyday living context.

Linking Science to Everyday Life and Societal Needs

We often do not realise the importance of science in our everyday life, and yet we make science-based choices every day. The choice of our food, products and many other things for our good health or how to lessen the damage to the environment is a science-based choice. For example, if we choose to eat a lot of fatty food, we risk ourselves of having high cholesterol and possible risk of getting a heart attack; or if we choose not to recycle, we may consume more natural resources without sustaining them to our future generation. Thus, many informed decision that human make that affect health, life and environment are indeed related to science.

Being able to understand and evaluate the information on science and technology is often perceived as being a scientifically literate person (Murcia, 2009). Besides understanding the issues such as acid rain and greenhouse's effect phenomena, a scientifically literate person is able to explain the issues such as the effect of acid rain to the living organism or the impact of greenhouse's effect on global warming. Young children tend to enjoy science, however when they get older, they often lose interest in learning science. For example, students learn that we need oxygen for breathing and somehow human needs trees to produce oxygen. However, when it comes to explaining the process of photosynthesis, it is where the real problem really starts because such simple information has been turned into a more complicated scientific event. Even most of the students have this knowledge stored but somehow they are not able to relate this to the real world of science and their life. This may be because there is too much concentration on science learning about facts, theories and principles. Another reason is

perhaps science appear to be a subject that focuses on 'covering' a set body of knowledge and skills in a short period of time rather than connecting the science concepts with the real world around them and everyday life. Would it be possible when the students could see the links between science curriculum and their lives, they would start to enjoy science more?

Having mentioned this, the most important thing to consider is how the teachers can attract students' attention and interest to be involved in learning science in more meaningful way rather than memorising facts and theories. For instance, the secondary school students are expected to acquire higher knowledge of scientific theories and principles, but rather some of them do not achieve good grades in science. According to the results for international assessment such as the Programme for International Student Assessment (PISA) for 2012 (OECD, 2013), students in Malaysia did not perform well in these tests in comparison to students in Singapore and Thailand. The items in PISA are more focusing on how students connect science with their everyday life and do not emphasis on the facts or theories. Example can be seen in one item on acid rain for PISA 2012:

> *Normal rain is slightly acidic because it absorbed some carbon dioxide from the air. Acid rain is more acidic than normal rain because it has absorbed gases like sulphur oxides and nitrogen oxides as well. …. Where do these sulphur oxides and nitrogen oxides in the air come from?* (OECD, 2013).

The question above shows that the expected answers are more on students' common sense and understanding of the situation that occur in our everyday life.

According to a research report by National Foundation for Educational Research (NFER) (2011), children enjoy learning science when they can relate the 'discovery of scientific knowledge' with their everyday life. Moreover, the enjoyment of science is also in connection with other subjects of interest such as sport science, nutrition and astronomy. On the other side, practical work appears to be the central attention whereby the individual and group gain hands-on experience by exploring science activities. Thus, in order to avoid too much emphasis on the content, theories, or principles of science, there are other topics that can be embedded in the teaching of science that relate more to students' everyday life experiences.

Teacher Participation in Professional Development. Teacher professional learning is a multifaceted process, which requires cognitive and emotional involvement of teachers individually and collectively, the capacity and readiness to examine where each one stands in terms of principles and beliefs as well as the perusal and enactment of appropriate alternatives for improvement or change. All these occur in particular educational policy environments or school cultures, some of which are more appropriate and conducive to learning than others (Avalos, 2011).

Professional development refers to activities to enhance professional career growth. Such activities may include individual development, continuing education, and in-service education, as well as curriculum writing, peer collaboration, study groups, and peer coaching or mentoring. In order to measure the quality of the teachers, teacher preparedness incorporates what the teacher brings to the classroom. Teachers' participation in any professional development programs should contribute to teachers being better prepared for the requirement of classroom teaching. There is evidence stated that teachers' professional development focusing on science content has a significant positive effect on students' achievement (Blank & de las Alas, 2009). Teachers are often responsible to any changes or implementation in

schools. Ali and Meher (2007) agree that quality of education depends on the quality of teachers and therefore teachers need a high degree of professional development. This professional development should be seen as a continuing process rather than as a one-off event and also needs to be sensitive to specific contexts. The curriculum for teachers' education should also not be limited to traditional curriculum areas—it needs to be diversified to include such cross-cutting themes as gender, citizenship and health education. Researchers and policy makers have determined that successful science professional development is heavily related to classroom practice. Understanding the impact of pedagogical contexts and the ways in which teachers are allowed to access their professional knowledge while learning science is very important because teachers could be assisted to compare the similarities between their own learning and their students' learning (Duzor, 2012).

Students' Understanding on Science and Everyday Life. Students often connect scientific learning to previous experiences and knowledge in consideration of personal values, ethics, and civic responsibility. Students also engage in educational experiences that explicitly illustrate how science, technology and society influence one another. A study by Krajcik and Sutherland (2010) has outlined that the key approach to foster science literacy is through inquiry. Feinstein (2011) declares that 'making science relevant' should be reconceptualised from being a teaching tool to becoming a measurable student outcome. Hence, allowing students to pose their own personally relevant questions can be critical for engagement. For instance, asking scientific questions that are relevant to their everyday life experience such as why peeled apple has brownish colour when being exposed to the atmosphere for a period of time or why ice can float on water. The idea of embedding science teaching and learning in context that is real and meaningful to learners had been explored extensively since 1980s until now and became associated with Science, Technology and Society (STS) (Fensham, 2009).

The issues about today's environmental problem is not local but on global scale. The issues such as acid rain, global warming or any other environmental destructions are affecting everyone on the globe no matter which race, age, gender or religion we are in. Therefore, not only the environmentalists are responsible for sustaining the environment, it is also everyone's duty to protect the environment. In a study conducted by Avci and Darcinm (2009), they found that the knowledge level of eight grade students on environmental problems like greenhouse effect, the deformation of ozone layer and the destruction of biological diversity are in fact very low. They added that majority of the students (70.6%) know that the factory chimneys and car exhausts cause acid rains but 50.2% of students have the wrong idea and made an incorrect correlation for the expression that the increase of acid percentage in the rains will also expand global warming.

Rationale of the Study

Students usually have some prerequisite knowledge of certain event or phenomena and bring it to the classroom. When they communicate the phenomena, they may not address it in a proper way, or they may not even realise that it relates to science. Students often connect their scientific learning to previous experiences and knowledge. Personal values, ethics, and civic responsibility also influence their perception in learning. Thus, it is very crucial for the teachers to engage students in educational setting that explicitly illustrate how science, technology, and society influence one another.

The rationale of this study is to provide an overview of a CPD course for teacher education and illustrate how the contents of courses are designed in such a way that address students' everyday life and the needs of society. The course aimed to equip the participants with

knowledge, new strategies and positive attitudes in linking science to their everyday life and the needs of the society. The participants were introduced to various strategies and approaches to enhance students' understanding of the importance of science and its relationship to our everyday life as well as the societal needs. The elements of the life skills were also incorporated in the course in order for the teachers to prepare their students with necessary skills and attitudes in dealing with science. The teachers were engaged in various problems and issues to develop higher order thinking, creative and critical thinking skills as well as decision-making skills. They collaboratively worked in groups, designed and implemented the science lessons and assessment materials using science, technology, environment and society-related issues.

With the new knowledge and skills acquired hopefully the participants can enhance the development of scientific and technological literacy in their students. The participants are also expected to be able to apply what they have learnt from the course and share it with their colleagues in their own country. With the rich experiences the participants were exposed to, it is hoped that it would broaden their views of science teaching and learning as well as eventually give them more confidence to transform their science classrooms into a more dynamic, interactive and stimulating learning environment, thus effect positive changes among their learners.

Research Questions

1. What are the teachers' knowledge and understanding of topics related to linking science and everyday life as well as societal needs?
2. To what extent do teachers aware of the importance to link science learning to everyday life and societal needs?
3. What are the teachers' perception and knowledge after being exposed to the topics that link science to everyday life and societal needs?

Methodology

Mixed-research with mixed-mode of data analysis was used for data collection and analysis of results involving mainly surveys (pre-/post-tests), observation and documentary analysis of learning output,

Sample

The participants involved were 20 teachers from South East Asian countries namely Brunei Darussalam (two participants), Cambodia (two participants), Indonesia (two participants), Lao PDR (two participants), Malaysia (two participants), Myanmar (two participants), Philippines (three participants), Singapore (two participants), Thailand (two participants), and Vietnam (one participant).

Data Collection and Analysis

Pre- and post-test were given on the first and last day of the course respectively. The data is analysed following the participants' average scores in response to the items based on Likert Scale as well as the net gain (i.e. the difference between pre- and post-tests scores). The following Likert scale was rated based on the participants' perceptions on their knowledge and skills on the listed topics:

a) Very low
b) Low
c) Moderate
d) High

e) Very high

For example, the participants were asked in the pre-test whether or not they had been exposed to the topics that were taught in the course to be elaborated under the following sub-heading. The same items were prepared in the post-test. Their responses were analysed as their perceived levels of knowledge and skills on each topic after they gain exposure in the 4-week course they attended

Course Contents (as elaborated in the course outline distributed to the participants during the course opening). This course showcases the effective application of theory into classroom practice by carrying out various investigative inquiry and discovery activities based on selected local, national and global real life issues. Special effort will be made to bridge the gap between classroom science lessons to meaningful learning for inculcating scientific and technological literacy as well as acquisition of life skills. The major topics/areas include:

a) Current issues and trends in science education relating to socio-economic and environmental development
   - Trends and Issues in Science Education
   - 21st Century Education Model

b) The concepts of scientific and technological literacy and life skills
   - Science and Technological Literacy (STL), Education for Sustainable Development (ESD) and Development of Life Skills
   - Science, Technology, Engineering & Mathematics (STEM)

c) Strategies including emerging technologies, ICT and multimedia resources to promote meaningful learning of science and attainment of life skills
   - Socio-scientific Approaches as well as Science, Technology, Environment and Society (STES)
   - Scientific Investigation of Issues Related to Science, Technology, Environment and Society (STES)
   - Inquiry Based Science Education (IBSE)
   - Technology Enhance Learning (TEL) in Secondary Science Teaching
   - Project Based Activity

d) Assessment
   - Assessment for Learning
   - ICT-based Assessment Tools

e) Planning, designing, developing and trying out sample lesson plans/ activities/materials with emphasis on the principles of instructional design and subject to lesson quality improvement process to produce science inquiry lesson plans and related teaching materials.
   - Principles of Instructional Design
   - Plan, Design and Develop Lessons Linking Secondary Science Learning to Everyday Life and Societal Needs
   - Implementing Lesson (peer and students tryouts)
   - Lesson Quality Improvement: Reflection, Feedback and Improving Lesson Plan
   - Compilation of Project Work

Workshop. Apart from the input of course contents through various interactive discussions and hands-on/minds-on blended-mode learning activities, the participants also attended a 2-

day workshop on 'Inquiry-based Learning' conducted by two consultants from University of Canterbury, Christchurch, New Zealand. On top of the input on the relevant topics for the course, the workshop was aimed for the participants to be able to:

- Improve experiences and outcomes (learning outcomes, engagement and well-being outcomes) in the classes in order to improve teaching and learning;
- Develop teachers' understanding and practice of teaching using inquiry based learning
- Promote sustainability of inquiry, and develop capability within the science department and school.

Project Work, Peer, and School Tryouts. The participants were divided into four groups and briefed on the instructional model as well as lesson plan. They were given the choice to select their own topic as long as it is within the scope of 14 years' old students and the issues must be related to everyday life issues as well as the emphasis is on the needs of the society. The participants also referred to the science syllabus in their respective country in order to generate the learning outcomes. As the project work focused on current scientific, technological, environmental or societal issues which portray the impacts of science and technology to society and the environment, the participants were expected to produce a course project work to integrate all the inputs by the course facilitators into a teacher resource material related to linking secondary science learning scenarios, assessments, task sheets, and instructional teaching aids.

After the participants in all project groups have prepared the lesson, they did the peer tryout with their peers. Then they amended the lesson based on the feedback from their supervisor and peers. Next, they carried out the real teaching and learning involving the students at the local schools. After the teaching, they prepared their individual group report which includes their reflection on the topics taught and the responses from the students during the tryouts. Their group report is compiled together with the reports of other project groups and submitted as a course report.

Enrichment Activities: Educational Tours. The educational tour within the state of Penang and Kuala Lumpur was organised to provide opportunity for the participants to gain exposure on the various cultures and traditions that we have in Malaysia. Also, the participants were involved in educational tour to local university and teachers' training institute. With the exposure gained through visiting local institutions in a local context, it is hoped that the learning is more contextual for them and they are better prepared to relate science learning in daily life.

Multiplier Effects Proposal. Each course participant was required to prepare and submit a proposal for enhancing the multiplier effects in his/her country through immediate or short/long-term implementation. The participants were given a template to make their individual plans of action. The course supervisor reviewed the drafts and the participants made revisions based on the comments and suggestions given until the proposals reach the final phase of editing and ready for submission as well as publication. They were expected to organise any courses in their respective country within two years upon completion of the regular course.

Results and Discussions

The Regular Course was successfully conducted for four weeks at SEAMEO RECSAM. This section analyses the data in response to Research Question (RQ) 1 to RQ3.

Understanding of Topics Related to Linking Science with Everyday Life and Societal Needs

The pre-test mean was 2.13 whilst the post-test mean 3.88 (Table 1). Based on the mean of the content gain as reflected in Table 1, it can be inferred that the majority of the participants expressed that they have acquired new knowledge on the designed topics, skills and values as revealed by their net gain of mean score with average 1.75 points when comparing their average post-test (3.88) and pre-test (2.13) results. Moreover, from the analysis of open-ended feedback, it was revealed that the majority of the participants expressed their great satisfaction with the contents and the overall implementation of the course.

Table 1

Pre-test & Post-test Results and Gains in Scores of Participants

No.	Name	Country	Competency of Course Content		
			Pre-test	Post-test	Gain
1	P1	Brunei Darussalam	2.20	4.44	2.24
2	P2	Myanmar	2.13	3.78	1.64
3	P3	Myanmar	2.21	3.89	1.69
4	P4	Lao PDR	2.46	3.64	1.18
5	P5	Thailand	1.90	3.68	1.78
6	P6	Thailand	1.67	4.32	2.65
7	P7	Philippines	2.04	4.86	2.82
8	P8	Philippines	2.20	4.15	1.95
9	P9	Philippines	2.03	3.74	1.71
10	P10	Cambodia	2.10	3.21	1.11
11	P11	Singapore	2.76	4.00	1.24
12	P12	Singapore	2.40	3.68	1.28
13	P13	Cambodia	1.11	3.18	2.07
14	P14	Vietnam	1.36	3.30	1.93
15	P15	Brunei Darussalam	2.17	4.50	2.33
16	P16	Lao PDR	2.86	3.68	0.82
17	P17	Indonesia	1.97	4.00	2.03
18	P18	Indonesia	2.03	3.64	1.61
19	P19	Malaysia	2.39	4.04	1.65
20	P20	Malaysia	2.59	3.85	1.27
		Average	*2.13*	*3.88*	*1.75*

Awareness of the Importance to Link Science Learning to Everyday Life and Societal Needs

Figure 1 shows the graph of the pre and post test results of the participants. The contents of the designed course are more focusing on relating science to everyday life and the needs of the society, rather than the content of science itself. From the participants' performance in the pre-test and post-test scores, it can be inferred that the participants have acquired enhanced levels of perception on the new knowledge and skills related to linking the secondary science learning to everyday life and the societal need. Based on the documentary analysis of project work report, it can also be inferred that the four project groups were able to reflect the importance of sustainability in human's life, and how our actions could lead to the destructions of the environment. Three of the groups did their projects on water but from different perspectives. Among the topics they planned for the science lesson include the importance of water for sustainability, water pollution, the quality of water for safe drinking, and healthy diet. All these

topics address common issues that are related to conservation and preservation of the nature as well as surrounding for the sustainability of future generations.

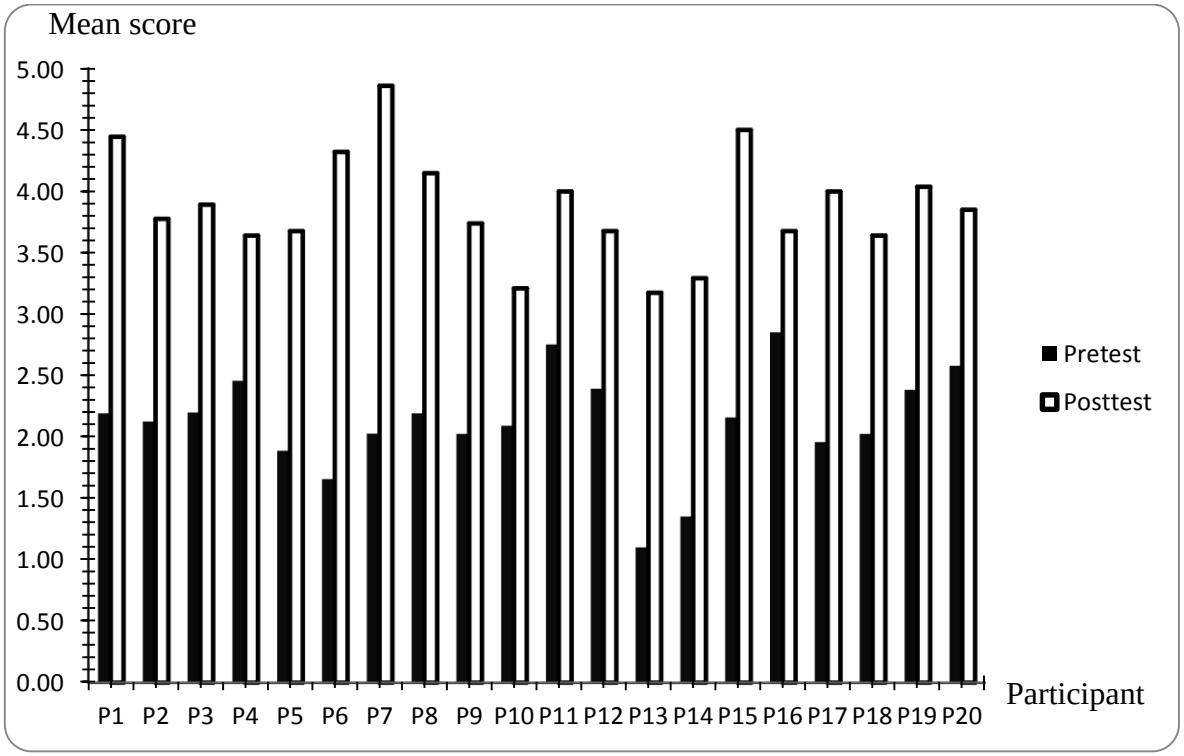

Figure 1. Graph of participants' scores in pre- and post-test.

Even though their pre-test results have shown their lack of knowledge and understanding of the designed topics, but their post-test results revealed different findings which indicate that the exposure on the designed topics such as ESD, STL, STES, STEM, Assessment and Theory into Practice (TIP) were very useful for them to link the content of science with their everyday life experiences. Following this, it is hoped that they will be able to apply their knowledge and understanding as well as use it to address the needs of the society. Furthermore, the participants also improve their skills in ICT from classes such as 21st Century Classroom Model, Technology Enhance Learning and ICT Assessment Tools.

As shown in Figure 1 with bar chart showing the pre-test and post-test scores of each individual participant, it can be seen that most of them (17 out of 20 participants) have scores in post-test that are quite distinctively different from their pre-tests which is above 3.5. The other three participants' post-test scores are still considered good that is 3 out of 5 points according to the Likert's scale. This shows that the participants have gained a considerable increase in their perceived levels of knowledge and understanding on the topics introduced in the course they attended.

The following photos were taken when the participants conducted their Peer tryout (Figure 2) of their secondary science lessons in one session at RECSAM.

Figure 2. Peer tryout.

The participants also carried out their school tryout (Figure 3) on 'Linking Secondary Science Lesson' at one local school the following week.

Figure 3. School tryout.

The above figures show that the participants worked very hard for the peer and school tryouts. They worked collaboratively in groups and were able to finish their project work as well as the multiplier effect proposal on time. They also showed their integrity as teachers and educators by demonstrating their pedagogical skills during the tryouts.

Perceptions and knowledge after the exposure to the course contents

The questions raised in the post-test contained all the topics that were taught in the Regular Course as reported under the sub-heading 'Course Contents'. The participants stated that 'their understanding of issues presented' had changed their perceptions. They expressed that all of the topics were very relevant to their everyday life and their thinking skills were enhanced with the ability to make decision on issues such as global warming, pollutions, water quality and many others. They stated that science education is very important for sustainability, specifically conserving and preserving the environment for the next generations.

The participants also believed that the emphasis in school assessment should not be so much on the grades but on how well students comprehend the issues that are related to science especially when it comes to learning the concepts related to issue such as sustainability. Most of them responded that they will incorporate such topics in science teaching, as well as conduct some in-house courses to their colleagues upon returning to their respective work place. The life skills elements that were embedded in the course were found useful and the participants

admitted that they were not aware of the importance of these skills to be instilled in the younger generations so that they would be able to solve issues in their everyday's life. They also realized that these issues could also be other than science-based phenomena.

In addition, the participants stated that what they treasured the most is the understanding and harmonious learning culture among the participants from different socio-cultural background. They also learnt a lot on how they can manage the project and work very well with one another, i.e. the attitudes and skills of which require mutual respect, tolerance as well as understanding among themselves. They mentioned that despite the individual differences in terms of religion, culture and belief, they learnt cooperatively to make their project work a success.

Conclusion

Science and technology play a fundamental role in supporting the continued functioning of the Earth as the life sustaining system. Scientific and technological knowledge and skills are increasingly important for the prudent management of the environment, for the socio-economic development to meet daily survival needs as well as for the sustainability of resources and future development of humanity. Hence, the teaching and learning of secondary science should be linked directly to the development of life skills among younger generation who will be facing the ever increasing challenges of the socio-economic and environmental changes in this modern era. The present young generation must be equipped with scientific and technological literacy and be creative to meet the societal needs, now and in the future. They should be able to make informed decisions, solve problems, and acquire life skills to improve quality of life and the environment. As such, teaching and learning of science must be made relevant and responsive to the emerging needs as well as changes of the Earth system and technological development.

The participants of this regular course have modelled humble attitudes to mix and work collaboratively with other participants from different countries, also respect one another regardless of their religion and traditions. They reflected in the interview that one of the values they learnt in this course is that everybody is a unique individual and good in their own way. Hence they had shown their patience with those who had difficulties in communication such as those who were not able to use English fluently either to communicate or express in their written work. For example, even though some participants were not very fluent in English, but they were willing to try and could make good video. Also, with the encouragement and support from other team members, those who were having difficulties using English were motivated to make presentation and involved actively in the activities. It is hoped that the learning experience gained by the participants and the report of findings from this study could serve as guide for the future conduct of relevant courses incorporating values-based education to benefit the educational system in the SEAMEO region and beyond.

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