EXEMPLARY PRACTICES IN SEARCH FOR SCIENCE AND MATHEMATICS RESEARCHERS (SERIES 5): 'SPECIAL PROJECTS/PROGRAMMES TO PROMOTE ESD AND EFA' (SpecP2E2)

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Abstract

*Education for Sustainable Development (ESD) includes an opportunity and motivation for all to be actively involved, with care for all living things considering environmental/ ecological, social and economy sustainability as well as Education for All (EFA). In response to the call for ESD/EFA, SEAMEO RECSAM has also embarked on various values-based projects/programmes and activities to promote ESD/EFA. These initiatives are in line with the aspirations of the Malaysian Ministry of Education (MOE) to promote values education as well as SEAMEO's seven priority areas and the global 'Sustainable Development Goals' (SDGs). In this fifth series of the article on exemplary practices in SEARCH for youth researchers through blended learning, elaboration will be made on another sub-portal of SEARCH, entitled '**S**pecial Projects/programmes to Promote ESD/EFA' (SpecP2E2). Tracer study with tracking of the milestones achieved in the endeavour of building the sustainability edge through institutional approach to promote ESD/EFA prior to and after the 'Decade of ESD' (DESD) from 2004 to 2014 will be reported. Evidences of exemplary practices in SEARCH for youth researchers supported by blended learning activities will be illustrated. The role of SEAMEO RECSAM as a regional training center in promoting informal science learning through various ESD/EFA related projects/programmes with exemplars will also be deliberated.*

***Keywords**:* Education for Sustainable Development (ESD); Education for All (EFA); Blended learning; Tracer study; Sustainable Development Goals (SDGs).

Introduction

Education for Sustainable Development (ESD) includes an opportunity and motivation to be actively involved at all levels, with care for the community of life and all living things considering environmental/ecological, social and economy sustainability as well as Education for All (EFA). Hence, apart from integrating ESD/EFA in formal science/social science curriculum, various institutes and training centres that are established in many countries also assist in promoting ESD/EFA through various projects/programmes. All these initiatives aim

at complementing formal science/mathematics learning through numerous nonformal/ informal learning and Continuing Professional Development (CPD) programmes.

Background and Rationale

In response to the call for ESD/EFA, Southeast Asian Ministers of Education Organization (SEAMEO) Regional Centre for Education in Science and Mathematics (RECSAM) has also embarked on various values-based projects/programmes and activities to promote ESD/EFA. These initiatives are in line with the aspirations of the Malaysian Ministry of Education (MOE) to promote values education (MOE, 2012) as well as SEAMEO's seven priority areas (SEAMEO, 2015) and the global 'Sustainable Development Goals' (SDGs)(United Nations, 2015). For example, in the recently launched SEAMEO 7 priority areas: A new education agenda (2015-2035), '*Revitalising teacher education'* and '*Adopting a 21st Century Curriculum*' are identified as the 5th and 7th priority areas (SEAMEO Secretariat, 2015). According to the Malaysia Education Blueprint (2013-2025) with 11 shifts to transform educational system, '*Develop values-driven Malaysians*' is the 3rd shift, '*Transform teacher into the profession of choice*' is the 4th shift and '*Leverage ICT to scale up quality learning across Malaysia*' is the 7th shift being emphasized (MOE, 2012).

This article reports the fifth of a series of a few completed and on-going blended-mode activities related to ESD/EFA initiated by RECSAM that are facilitated through the web-based learning portal entitled '**S**outh **E**ast **A**sia **R**egional **C**apacity-enhancement **H**ub' (SEARCH) [http://www.recsam.edu.my/search/index.html]. Tracer study with tracking of the milestones achieved in the endeavour of building the sustainability edge through institutional approach to promote ESD/EFA prior to and after the 'Decade of Educatio for Sustainable Development' (DESD) from 2004 to 2014 will be reported. Evidences of exemplary practices in SEARCH for youth researchers supported by blended learning activities will be illustrated focusing on another sub-portal of SEARCH, entitled 'Special Projects/programmes to Promote ESD/EFA' (SpecP2E2) [http://www.recsam.edu.my/search/p2e2/]. The role of RECSAM as a regional training center in promoting informal science learning through various ESD/EFA related projects/programmes with exemplars will also be deliberated.

Research Questions

This paper seeks to examine the following research questions:

(1) To what extent SpecP2E2 (a sub-portal of SEARCH) has been leveraged on to raise awareness, disseminate information/resources on values-based project/programme related to ESD/EFA and what are the exemplary practices or evidences of research activities?

(2) What are the salient features of institution-based approaches to affect how knowledge related to ESD/EFA is exchanged though blended learning platforms that may reflect and enhance the RECSAM's role as Regional Centre of Expertise (RCE) in Science and Mathematics education to promote ESD/EFA in SEAMEO region and beyond?

It is expected that at the end of the study, more insights could be gained to develop roadmap for the way forward to promote ESD/EFA through the 'building of sustainability edge through institutional technology-enhanced strategies'. The subsequent review of literature will also guide the framework of study.

Literature Review

Enhancing Awareness of ESD/EFA Leveraging on Blended Learning Platforms

Science and social science education in the school curriculum play important roles in the aspects of promoting Education for Sustainable Development (ESD) and ensuring Education for All (EFA). Hence since the launching of DESD (2005 to 2014) to enhance education as the basis for sustainable human societies and to strengthen international cooperation in disseminating environmental information (Ikeda, 2002), many programmes were initiated to raise awareness of ESD/EFA using institution-based approaches. For example, the SEAMEO-UN-HABITAT cooperative project to promote "Human Values-based Water, Sanitation and Hygiene Education" (HVWSHE) in Southeast Asian Schools was initiated to support ESD related Millennium Development Goals (MDGs) No. 5 and 7 (Dzikus, 2007) set by the United Nation (UN). HWSHE or sometimes being referred to as "Water and Values Education" (WAVE) (SEAMEO Secretariat, 2007) is an innovative approach to impart information on water, sanitation, hygiene, also to inspire and motivate learners to change their behaviour towards promoting wise and sustainable use of water. This aspect is still emphasized in 'Sustainable Development Goals' (SDGs)(United Nations, 2015). The missing link in education to support student learning regarding sustenance of all life with water as an important life giving aspect was high;ighted in the projects.

Reorienting existing education at all levels with training and curriculum development' as reflected in HVWSHE is an important approach adopted by institution to address ESD concepts (UNESCO, 2002). Leaders should consider rethinking and revising the current educational system from nursery school through to university. This involves the efforts to address the three pillars of ESD that are important to the societies, i.e., social, environmental and economical sustainability by including more principles, skills, perspectives and values in each of these three realms. In line with the philosophy of ESD and EFA, there is also a need to 'develop public understanding and awareness of sustainability' (UNESCO, 2002). Knowledgeable consumers who are aware of the current trends and issues related to ESD can help the governments and communities to enact sustainability measures. In addition, the human aspect and its integrity, an important part of ESD is leftout in the curriculum. The move towards collaborative learning has been a focus in the ESDs.

Tracing Milestones of Leaderships in Regional Institutions with Partners for ESD/EFA

Realizing that developing scientific skills, values, attitudes and infrastructure is the first step towards improving institution's efforts to use science and technology to promote ESD/EFA (Sawahel, 2007). Emphasis was placed by many aspiring sustainable campus to promote inquiry-based science education. Literature revealed that the constructivist problem-solving curriculum through situated learning or shared cognition with guidance by adults as educational leaders or More Knowledgeable Others (MKO)(Larkin, 2002) and capable peers in Community of Practice (CoP) was found to be effective by educators/researchers. In CoP, learners and stakeholders are connected for various reasons to interpret, reflect and negotiate meaning in an open process via meaningful interactions (Wenger, 2000). The study by Crawford, Krajcik & Marx (1999) revealed that CoP with desirable environment could provide opportunities for students to engage collaboratively in solving contextual problems, hence inculcating cooperative skills that are important to promote Global Citizenship. In fact CoP is practised in many educational institutions especially those involved in the education and training industries including the Southeast Asian Ministers of Education Organisation (SEAMEO) – Regional Centre for Education in Science and Mathematics (RECSAM). SEAMEO RECSAM, one of the 21 centres established by SEAMEO and is located in Penang, Malaysia, is mandated to

enhance teachers' teaching competence through training as well as research and development (R&D) activities since its inception almost 50 years ago. Since 2008, the centre was also nominated as one of the stakeholders of the Regional Centre of Expertise (RCE) with exemplary practices in collaboration with partners for ESD/EFA.

Tracking the progress or milestone (i.e., a significant stage or event in certain development) through tracer study or performance assessments is an important step towards determining the future direction of an organization as it is necessary to understand its current position in order to plan the roadmap or strategy. Tracer study is programme-led, most of which have been done retrospectively, mostly implemented by external researchers to find out more about a programme and its participants, i.e. those who were meant to benefit from the programme ideas undergoing development. It represents an approach or practical tool that allows researchers to look more deeply into their own work in the field, starting from objectives, goals and context of a programme with reflection on personal outcomes and how the mass of information that results is often put to immediate use. Its overall objective was to assess, look for effects and to find out what has happened over a specific period. Research questions should lead to an exploration that attempts to find out how life is for the former participants. The researchers explore if the actual impact on people can be directly related to the conceptualization and operation of programme, changing or refining how effectiveness is perceived, modifying or adding to the programme's objectives and fine-tuning programme content or changing the ways in which it is structured and run (Cohen, 2004; ILO, 2014).

Methodology

In this paper, tracer study is used to track the progress of the implementation of ESD/EFA with mixed-research analysis identifying traits on how knowledge is used or exchanged. Tracer study is intended to explore the degree to which different strategies result in more or less dissemination of knowledge about ESD/EFA through projects/programmes.

Tracking Milestone Achieved through Tracer Study

Tracer study is incorporated as research methodology to explore the degree to which Centre's different strategies implemented since 2004 result in more or less dissemination of knowledge about ESD/EFA beyond the direct recipients in the first part.

An analysis of the selected projects/programmes implemented especially 2004 to 2014 (DESD) until today was made to examine whether these were implemented in accordance with ESD/EFA related themes and philosophical practices. Since a minimum of 5 years participation by stakeholder was set as the criteria for the programme in line with literature, the key aspects of the implementation of three programmes identified to have higher impact were summarized in the Tables as illustrated in 'Findings' section in terms of 'the strategies used' by each programme and the 'dissemination of ESD/EFA concepts'. The impact of the dissemination of ESD/EFA-related output was evaluated based on the number of publications as research project, book and/or research paper. More elaborations were made on program implementation for programs considered to have a greater or long term effects. These include 'the tracking of milestones, the way forward or recent initiative' with identification of essential traits that contribute to 'how knowledge is exchanged and used' at various levels of implementation in the SEAMEO region and beyond. This is because an important rule might be to ensure that the programme keeps good enough records from the very start so that tracing will be possible in future as and when it is decided to do so with more information to demonstrate its impact (Cohen, 2004).

Analyzing Data with Case Examples using Mixed-research Mode Technique

Tracer study is complementary to other research approaches and could be the ideal tool to explore with deeper understanding and knowledge about a specific aspect of programme. Tracer study that demonstrates a continuing impact on participants some years after involving in the programme can be a useful contribution to the argument to demonstrate impact. 'Mixed-method with quantitative approach using figures or qualitative approach with real insights on problems/solutions' are useful especially when both being used together can show gaps, indicate trends and demonstrate change over time (Johnson & Onwuegbuzie, 2004).

In the second part that included case studies with in-depth accounts of specific aspects of programme(s), the researchers examined the salient features/traits of institution-based approaches to t 'how knowledge related to ESD/EFA is exchanged and used' that may reflect or further enhance the centre's ESD/EFA philosophy and roles as stakeholder of Regional Centre of Expertise (RCE) anchored on the social constructivist and socio-cultural framework. These include reflections on how the centre recognized change in any remaining and ongoing programme(s) that still influenced people's lives (e.g., their understanding and attitudes towards ESD/EFA), and how the samples being studied (e.g., the case study schools/teachers) are faring. Mixed-methods research mode was used to collect and analyze data, involving interviews, observations, discussions, surveys or rating scales (e.g., to measure opinions) and examination of archival records or documentary analysis of the output by selected respondents for interview or survey. Research process also involved triangulation considering research ethics, culture and context of research data being examined (ILO, 2014).

Data Analysis and Discussion of Findings

This section analyse data with discussion in response to Research Question (RQ) 1 and RQ 2.

Case Examples of RECSAM's Roles in Raising Awareness of ESD/EFA Concerns

The Centre's programmes implemented in accordance with ESD/EFA related issues were analyzed for RQ1 'To what extent the SpecP2E2 (sub-portal hyperlinked to RECSAM's SEARCH portal) has been leveraged on to raise awareness, disseminate information or resources on values-based project/programme related to ESD/EFA with exemplary practices':

(1) Centre's roles as clearing house to disseminate ESD/EFA related informa- tion or publication. A sub-portal entitled '**S**pecial Projects/programmes to **P**romote **E**SD/**E**FA (SpecP2E2) was developed and hyperlinked to main portal '**S**outh **E**ast **A**sia **R**egional **C**apacity-enhancement **H**ub' (SEARCH) that is the. [URL: http://www.recsam.edu.my/search/p2e2/](Figure 1). Various topics related to ESD/EFA were identified with links or URLs of the web-based resources provided.

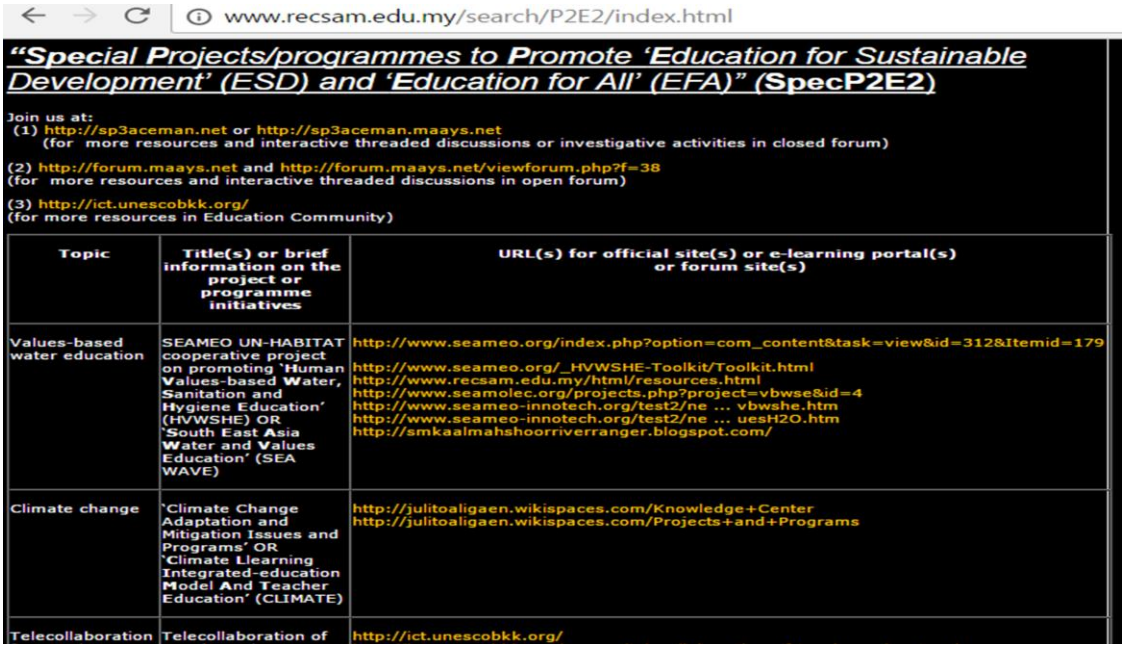

Figure 1. Sub-portal 'Special Projects/programmes to promote ESD/EFA (SpecP2E2) hyperlinked to SEARCH portal [URL: http://www.recsam.edu.my/search/p2e2/].

The following are discussion of the Centre's roles as clearing house or training centre to disseminate information or publication related to ESD/EFA.

(i) ***Values-based Water education and Nature Connectedness research studies***. Among selected publications are 'Human Values-based Water, Sanitation and Hygiene Education' (HVWSHE) regional and national training reports (Ng, Azian, Cheah, & Devadason, 2007; Ng, Azian, Cheah, Tan, & Toh, 2008)(with toolkit available online as shown in Figure 2) and Children's nature connectedness (CNC) (Hazura, Nur Jahan, Ng, & Corrienna, 2013).

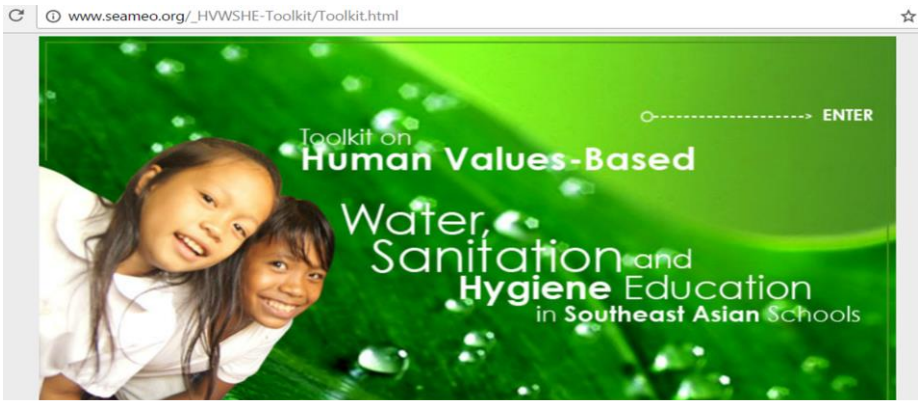

Figure 2. Toolkit on Human Values-based Water, Sanitation and Hygiene Education (HVWSHE) in SoutheastAsian Schools [URL: http://www.seameo.org/_HVWSHE-Toolkit/Toolkit.html]

(ii) ***Climate Change and Environmental Education as output from curriculum development workshops***. Among the related publication include Climate Change (Azian, 2010) and other resources related to Climate Change education available online (Figure 3).

Figure 3. Projects and programs related to Climate Change Integrated Education. [URL: julitoaligaen.wikispaces.com/Projects+and+Programs]

(iii) ***Traditional knowledge in sustainability as output from seminar/workshop.*** Research studies related to traditional knowledge in sustainability of language and culture were published in the proceedings of conference/seminar of '**S**outheast **A**sian **C**ulture and **S**cience **G**roup' (SACAS)(Loo & Sarmiento, 2006) accessible online.

(iv) ***ESD related research involving PBA/PBL lessons and investigative projects***. Among related publications include Journey to Investigative Research (Ng, 2012), Going global in SEARCH for science and mathematics researchers, Promoting investigative research through blended learning (Ng, 2013).

(2) Centre's roles as catalyst of change to promote awareness on ESD/EFA. The following are various activities initiated to promote awareness on ESD/EFA leveraging on the web-based resources available online and partly disseminated through SpecP2E2.

(a) Conducting in-service trainings and/or curriculum writing workshops related to ESD/EFA. Among the course topics directly related to EE/STS/ESD/EFA include (I) Investigating interactions in STES at secondary level (a) SS-0500 (30/8-9/10/2004) and (b) SS-1444 (2/7-27/7/2007); (II) Exploring interactions in STES and ESD at Primary Level (PS-1444)(6/7-31/7/2009); (III) Promoting STL in (a) secondary (SS-1100)(5/9-30/9/2005) (b) primary (PS-1100)(31/3-25/4/2008) students for lifelong learning. (IV) Promoting ESD/EFA through LeSMaT (Borderless) curriculum or module writing and editing workshops (2015-2016) on topics 'Telecare and Healthy Lifestyle' (TeleHeal); 'Conservation and Wise Use of Resources' (ConWUR); 'Climate Awareness and Disaster Risk Reduction Education' (CADRRED) and 'Sustainable Energy for All' (SE4ALL).

(b) Sharing issues or new knowledge through blended-mode colloquia, seminars, conference using various digital tools and social learning platforms. Among the modes of sharing included the conduct of colloquia, seminars, conference, forum, congress and/or in-service course/workshop, some of which were supported by digital tools such as Skype, webinar and social learning platforms such as FB (Refer an example in Figure 4) and Edmodo (Refer an example in Figure 5 on the permanent platform to disseminate info related to

registration of accounts in Edmodo). Apart from the current issues on Climate Change, scientific and technological literacy (STL), HVWSHE, SACAS, ESD/EFA that were published and widely distributed as aforementioned, there are also other current issues or new knowledge disseminated as the stakeholder of 'Regional Centre of Expertise' (RCE) since 2008. These included PBA, PBL, green building, Borderless School [that was renamed since 2015 as 'Learning Science and Mathematics Together' in the borderless world or in brief LeSMaT (Borderless) students' networking project initiative], sustainable living and Disaster Risk Reduction Education (DR RED).

Figure 4. An example of use of FB event page to invite blended-mode participation to attend forum conducted in conjunction with the 9th SSYS congress [URL: https://www.facebook.com/events/1401275593457278/].

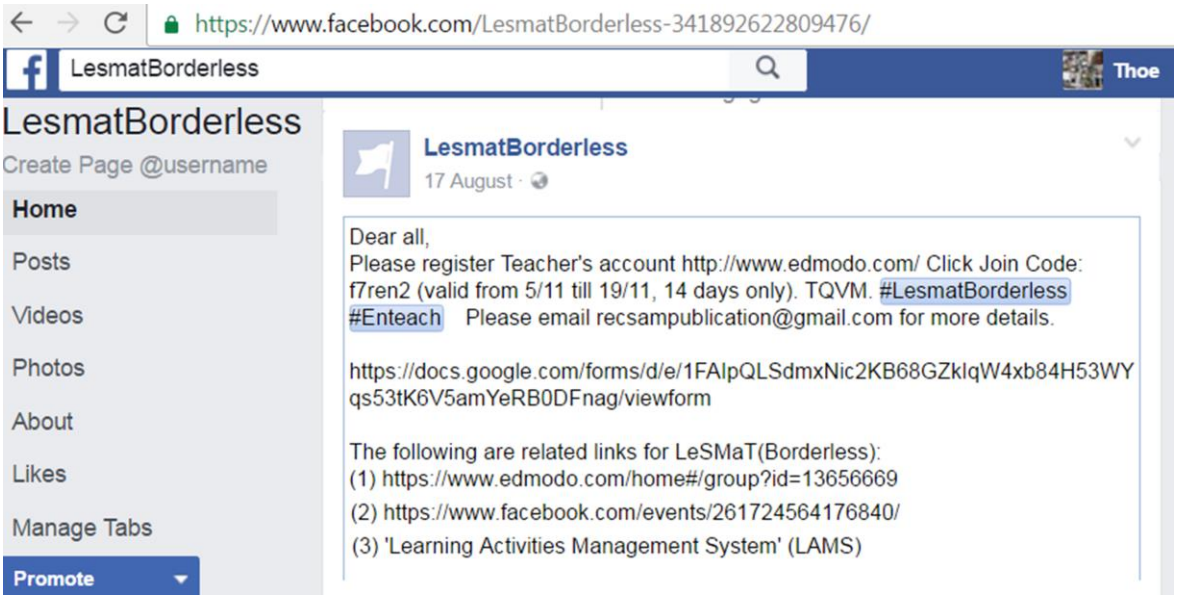

Figure 5. An example of use of FB page@username to disseminate information on registration details for Edmodo social learning platform for blended learning [URL: https://www.facebook.com/LesmatBorderless-341892622809476/].

The Salient Features of Institution-based Approaches to Affect how Knowledge is Exchanged/Used that Reflect and Enhance the Role of Centre as Stakeholder of RCE

The following section to RQ2: "What are salient features of institution-based approaches to affect how knowledge related to ESD is exchanged through blended learning platforms."

Another aspect of tracer study was also to determine the factors that affected or contributed to how knowledge was exchanged and used at various levels of implementation in the SEAMEO region and beyond. With regards to these aspects, the mixed-mode research techniques for data analysis are discussed.

The analysis of base-line data revealed that three institution-based programmes were identified to have evidence-based output in terms of the key aspects of implementation, i.e. 'the strategies used' by each programme and the 'dissemination of ESD concepts' as summarized in the following Table 1.

Table 1

Analysis of the Extent to which Different Strategies of Programmes with Higher Impact Result in the Dissemination of Knowledge about ESD via Research Projects, Books/Papers

Programme *(timeframe)*	**Approaches/Strategies, [URLs] and/or Themes**	**Dissemination of ESD related work/findings in:**	
		Research projects (N_1)	**Books (N_2)/Research papers (N_3)**
'**H**uman **V**alues-based **W**ater, **S**anitation and **H**ygiene **E**ducation' (HVWSHE) or (SEA WAVE) (SEAMEO Secretariat, 2007) (2007-2013)	Curriculum development on Water/EE, Training of Trainers (TOT) regional level, echo-training at national level, PBA/PBL via blended learning [http://www.recsam.edu.my/search/; forum.sp3aceman.net; http://www.seameo.org/_HVWSHE-Toolkit/Toolkit.html]	N_1 = **4** (Ch'ng, et al., 2007; Isma, et al., 2007; Tan, et al., 2007; Toh, Muhammad, Phetsa-mone & Daw, 2007)	N_2 = **2;** N_3 = **10** (Pannen, Ng, Ikhsan, Mustafa & Herawati, 2007; Ng, 2010) (Ch'ng, Tan & Ng, 2007; Isma, Kaur, Wee, Zahari & Savuth, 2007; Ng, 2009; Ng, Teoh & Tan, 2007; Tan, Leong & Ng, 2009; Toh, 2008; Toh & Ng, 2007; Toh, Yeap, Ng & Isma, 2007; Ng, Parahakaran, Febro, Weisheit & Lee, 2013; Toh, Ch'ng, Parahakaran & Ng, 2013)

Climate **C**hange **I**ntegrated **E**ducation **M**odel (CCIEM) or (SEA CLIMATE) (2008-2014)	Curriculum development on EE, Training of Trainers (TOT) at regional and national levels, PBA/PBL integrating blended mode learning [http://www.recsam.edu.my/search/P2E2/index.html; http://julitoaligaen.wikispaces.com/Projects+and+Programs]	N_1 = **2** (Aligaen, 2011; Aligaen & Mangao, 2012b)	N_2 =**2;** N_3 = **8** (Azian, 2010; Ng, 2010) (Aligaen, 2010a, 2010b; Aligaen, 2013; Aligaen & Mangao, 2012a; Aligaen & Mangao, 2012c; Aligaen & Mangao, 2013; Ng, Aligaen, Ab. Bakar, Abdul-Talib & Ahmad, 2013; Aligaen, Thien & Ng, 2014)
'**S**earch for **S**EAMEO **Y**oung **S**cientists' (SSYS) (1997-2016)	Organization of congress as platform to promote student-centred PBA/PBL integrating blended mode learning [http://www.recsam.edu.my/ssys]	N_1 = **195** [*SSYS 1997 to 2008 projects archived onto: http://forum.sp3aceman.net*]	N_2 = **3**; N_3 = **9** (Ng, 2010; 2012b; Campbell & Robottom, 2013)
(8-10/3/2004)	***Towards a sustainable future***	20 science projects	(Ng, 2005, 2008; Ng, Sarmiento, Cheah, Wahyudi, 2006; Sarmiento, Ng, Cheah, Wahyudi, 2006; Ng & Mangao, 2009; Mangao & Ng, 2012; Ng, Soon, Kim, Toh & Lay, 2013; Mangao, et al., 2013; Ng, Mangao, & Baharulnizam, 2014; Khor, Teh, & Lee, 2016)
(6-9/3/2006)	***Sustainable development for a better world***	21 science Projects	
(3-6/3/2008)	***Sustainable community development through science and mathematics***	19 science and 12 mathematics Projects	
(2-5/3/2010)	***Sustainable solutions for local community***	31 science and 10 mathematics projects	
(6-9/3/2012)	***Beyond 2012: Greening the environment for a sustainable future***	30 science and 15 mathematics projects	
(3-7/3/2014)	***Disaster Risk Reduction (DRR) for Sustainable Development***	27 science and 10 mathematics projects	
(7-11/3/2016)	***Youth Innovation for Sustainability***	28 science and 10 mathematics projects	

(1) **Knowledge exchange**. SEAMEO RECSAM serves as catalyst for the promotion as well as clearing house for the dissemination of information through organization of ESD/EFA

related activities. The programmes related to knowledge exchange of ESD/EFA that are analyzed as shown in Table 1 are namely:

i. '**H**uman **V**alues-based **W**ater, **S**anitation and **H**ygiene **E**ducation' (HVWSHE) or '**S**outh **E**ast Asia **W**ater and **V**alues **E**ducation' (SEA WAVE) [http://www.recsam.edu.my/search/P2E2/index.html and http://www.seameo.org/index.php?option=com_content&view=article&id=250& Itemid=585](2007 to 2013);

ii. '**C**limate **C**hange **I**ntegrated **E**ducation **M**odel' (CCIEM) or **S**outh **E**ast **A**sia **C**limate **L**earning **I**ntegrated-education **M**odel **A**nd **T**eacher **E**ducation' (SEA CLIMATE)(2008 to 2016); and

iii. '**S**earch for **S**EAMEO **Y**oung **S**cientists' (SSYS) regional congress (1997 to 2016).

These programmes are mostly conducted through the following modes:

(a) ***Face-to-face***. The activities conducted using this mode including in-service training programmes/courses, conferences/seminars/colloquia/congresses. The above Table 1 summarises the approaches/strategies in 'Human Values-based Water, Sanitation and Hygiene Education '(HVWSHE) and Climate Change project initiatives with dissemination of ESD related work and findings in research projects, books and research papers. The total number of research projects (N_1), books (N_2) and research papers (N_3) with selected publication titles summarized inside (surname of first author, year of publication) as listed in Reference list are provided as evidence to support the findings in response to RQ2.

Apart from HVWSHE and CLIMATE, there are also other events such as congresses/conferences/symposium that were conducted during the biennially held 'Search for SEAMEO Young Scientist' (SSYS) congresses and Conference on Science and Mathematics Education (CoSMEd), as well as the recently concluded (25-27 October 2016) fourth International Conference on ESD (ICESDev) with ESD/EFA as main or sub-themes for discussions by national and international delegates. These activities were conducted mainly face-to-face at the Centre's venue, supported occasionally with digital tools such as webinar, e-forum, skype and social networking sites.

Responding to RQ2: "What are the approaches to affect how knowledge is exchanged and used", mixed-mode of data analysis (include mainly observation, interview and content analysis) were used with findings summarized in Table 2. ESD related project that promoted innovation and enhance human resource development through student-centred PBA/PBL are summarized in the following table. These projects are also archived in e-forum site of '**S**cience **P**roject/problem/programme-based **A**ctivities in**C**orporating **E**xperiment **MAN**agement' (SP3ACEMAN) that is another sub-portal hyperlinked to '**S**outh **E**ast **A**sia **R**egional **C**apacity-enhancement **H**ub' (SEARCH) (series 3 reported in 2014) to promote *sustainable knowledge management system.*

Table 2
ESD Related Disciplines of Student Research Presented in the SSYS Congresses (2004-2014)

ESD related areas of disciplines or Field of combined studies	SSYS congresses held during DESD						Total Project	%
	2004	2006	2008	2010	2012	2014		
Biodiversity conservation; Preservation of diverse plant and fish species (Aquaculture)	-	1	1	1	8	5	16	8.21
Biotechnology; Genetic engineering; Food technology; Nutritional products	7	6	-	1	2	4	20	10.26
Energy efficiency; Renewable/Green energy	-	-	1	2	3	3	9	4.62
Sustainable management of water resources; Monitoring of flood/water/air pollution; Environmental science	1	1	3	11	7	7	30	15.38
Sustainable transportation	-	-	-	1	-	-	1	0.51
Waste management/Recycling of waste products; Environmental/Health education	-	1	2	1	7	2	13	6.67
ESD related project integrating concepts of:								
Biology	7	2	-	3	-	-	12	6.15
Chemistry	1	3	2	3	1	-	10	5.13
Physics	1	1	-	-	2	2	6	3.08
Forestry/Flora	-	1	1	-	2	1	5	2.56
Biochemistry	-	-	1	3	-	-	4	2.05
Microbiology/Microorganism	2	4	-	4	-	-	10	5.13
Medical science/Disease control	-	-	3	-	-	2	5	2.56
Technology/ICT applications	-	-	1	-	3	2	6	3.08
Mathematics/Statistical applications/ Mathematical modeling	-	-	12	10	7	4	33	16.92
General Science, GeoScience/Geochemistry/Physical science, Geography,	-	-	-	-	-	1	1	0.51
Meteorological data/weather forecast, Detector (e.g. gas leakage, etc.)	-	-	-	-	2	-	2	1.03
Others (e.g. air/wind/ water; shoreline/ coastal resource; earth/mining; product packaging; tourism; arts/ recreational/souvenir/cosmetic items)	1	1	4	1	1	4	12	6.15
Total	20	21	31	41	45	37	195	100

(Adapted from Ng, Sarmiento, Cheah & Wahyudi, 2006; Mangao, 2008; Ng & Baharum, 2013; Ng et al., 2014)

(b) ***Blended mode***. Apart from off-line or face-to-face activities, some of the projects/programmes conducted were supported by on-line or e-learning and m-learning tools for asynchronous and synchronous communication to ensure social sustainability and encouraged wider participation in the community of SEAMEO and beyond. These included emails, synchronous chats and video conferencing through e-portals [SEARCH e-learning hub supported by its sub-portal '**Spec**ial **P**rojects/programmes to **P**romote **E**SD/**EFA**

(SpecP2E2)(http://www.recsam.edu.my/search/P2E2/index.html) and e-forum http://forum.sp3aceman.net], Learning Activity Management System (LAMS) [http://elearn.recsam.edu.my:8080/lams], webinar supported by Intel teach programme, Facebook (FB) and other social learning or networking site such as Edmodo, and so forth.

The following are discussions on another trait to promote ESD/EFA supported by technology.

(1) **Knowledge consumption and application**. This aspect was examined through 'tracking milestone achieved' and 'follow-up activities conducted to be elaborated.

(a) ***Tracking milestone achieved.*** Tracer study is another form of impact study. Hence the 'tracking of milestone achieved in facilitating knowledge consumption and applications of ESD/EFA concepts' was evaluated through impact studies on various special projects/programmes to promote ESD/EFA. The evaluation methods included mainly observation and interviews conducted with participants involved in the two main activities identified, i.e., HVWSHE or SEA WAVE and SSYS programmes, with triangulated findings from documentary analysis of archival records or project output, as summarized in **Appendix A** Table A(1) on the centre's recently implemented ESD/EFA related activities.

Since the implementation of HVWSHE and CLIMATE programmes, the centre practised ESD/EFA related activities, such as (1) rain water harvesting; (2) the setting up of three-coloured waste separation bins to collect waste papers, aluminium cans and plastic bottles for recycling; and (3) organizing (a) composting workshops such as Takakura composting method with input given by Japanese experts, (b) colloquiua with local experts invited to brief on topics related to waste management and pollution control. Few staff members were also involved in ESD related community services such as preparation of mug-balls to assist the nearby community and state government in cleaning drains and seaside.
A visit was also made in a boarding school with interviews of a Master teacher involved in Regional Training of Trainers (TOT) and National Echo-training (NET) courses on HVWSHE in 2007-2008. In fact this school was also visited in the years 2010, 2011 for some follow-up HVWSHE activities and in 2013 with advice on possible ESD related activities that the school may participate. The achievement shared by the respondent teacher was encouraging. The teacher felt that he was inspired by his previous involvement in HVWSHE to lead the school for more green initiatives [such as rainwater harvesting as shown in A**ppendix B** Figure B(2), waste management, pollution control, tree planting] that led theschool claim awards namely MPSP Green school Silver award (2010-2011), MPSP Green school Gold award third place in 2012 and first place in 2013; and Champion Chief Minister Green Award 2013 (Tan, 2014).

SSYS biennially held events and other curriculum writing workshops (e.g., HVWSHE, SAW) also spearheaded many green initiatives and outreach programmes in collaboration with local/international experts in the CoP facilitated using blended learning approaches. These included the 'Green Building', '**D**isaster **R**isk **R**eduction **ED**ucation' (DR RED) projects, and initiatives to develop 'sustainable knowledge management system and enhance social sustainability' through networking sites such as Facebook (FB), Edmodo, LAMS and one-stop 'SEARCH' portal [http://www.recsam.edu.my/search] hosted by the Centre. The following programmes were also summarized in the forms of posters or research papers published in journals, e.g., 'Learning Science and Mathematics' (LSM) on-line journals [http://www.recsam.edu.my/lsm/index.htm]: (1) '**S**cience **A**cross the **W**orld' (SAW) by Ng, Toh and Boey (2010); (2) '**MA**gnificent **A**dvancement of **Y**oung **S**cientists' (MAAYS) and

'**S**earch for **S**EAMEO **Y**oung **S**cientists' (SSYS) by Ng et al. (2011); (3) SP3ACEMAN by Ng et al. (2013); and (4) SSYS by Ng et al. (2014), Khor et al. (2016).

In addition, prior to CoSMEd 2013 organized at the Centre, interviews were made with three ex-participants on their involvement related to HVWSHE and other green initiatives as they had prepared poster presentation for CoSMEd 2013. Apart from the River Ranger project uploaded online and the outstanding performances of their students who participated in SSYS congresses [**Appendix B** *Figure B(1)*], the respondents reported to have involved in several national and international competitions directly/indirectly related to the application of the knowledge they gained from attending the in-service courses. Among their other awards include innovative and icon teachers of the year at state and national levels.

(b) ***Follow-up activities conducted.*** Since tracer study can be more beneficial with follow-up activities (e.g., its output inspired the planning of the way forward), it is thus important for the Centre to continue with the efforts to facilitate 'knowledge consumption and applications of ESD concepts' with more impacts to be tracked. A survey was prepared, piloted in February 2014 and administered during the 9th 'Search for SEAMEO Young Scientists' (SSYS 2014) [http://www.recsam.edu.my/ssys] in line with the congress theme 'Disaster Risk Reduction for Sustainable Development', analysed and presented in the conference (Ng, Chockalingam & Thien, 2014 in Ng, Parahakaran & Thien, 2015). *Figure 6* shows the event page created in FB (that was also done for SSYS 2016) to invite participation through webinar.

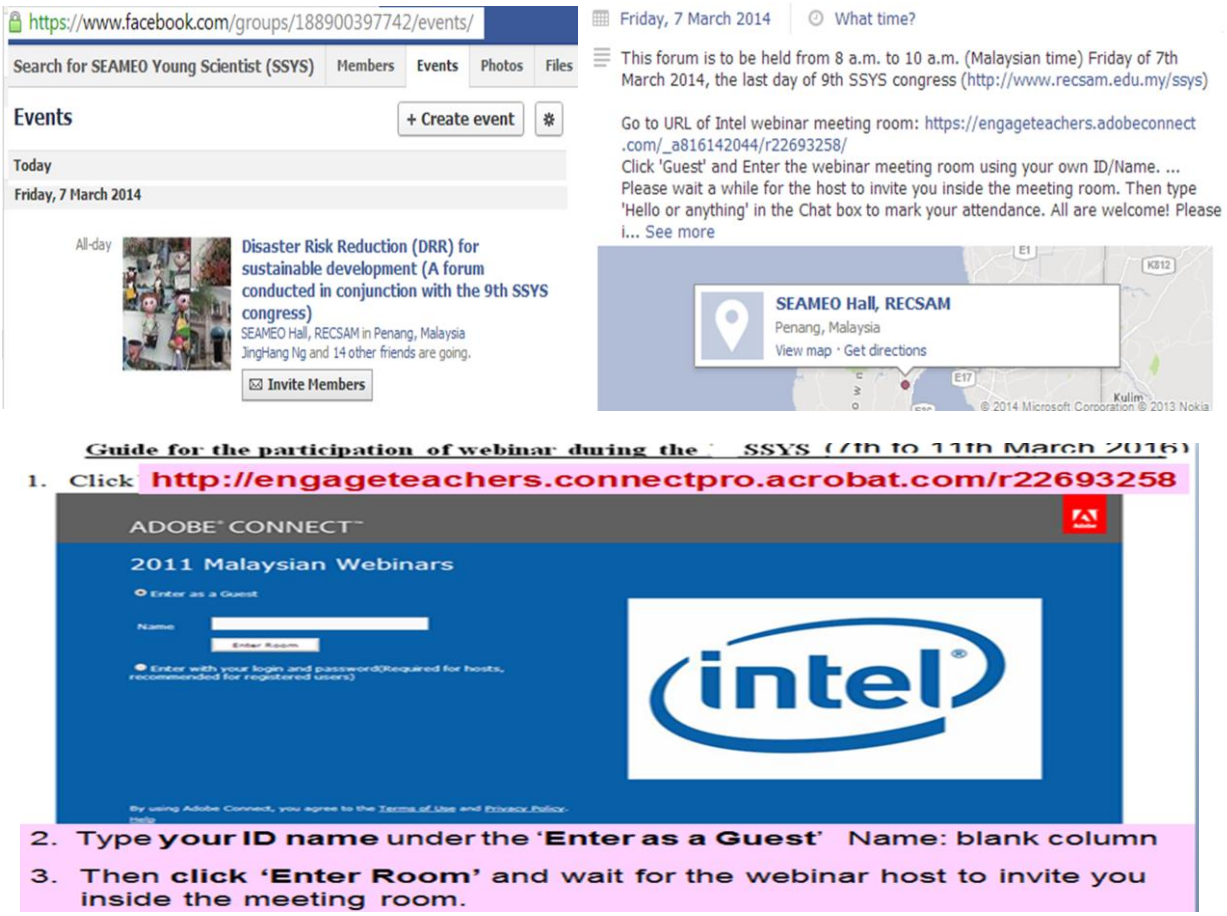

Figure 6. SSYS forum page created in FB [https://www.facebook.com/events/1401275593457278/] to invite participation using Intel webinar [https://engageteachers.adobeconnect.com/_a816142044/r22693258/].

Conclusion

This study examines the roles of SpecP2E2 in SEARCH for science and mathematics researchers by tracing the Centre's activities within and after the period of DESD as well as the lessons learnt for the way forward through international networking using blended approaches as social imperative for leaderships in ESD/EFA.

Summary of Discussion and Limitation of Study

The paper first elaborated on the directions that had an impact on the ESD/EFA related programmes (e.g., HVWSHE, CCIEM or CLIMATE, SSYS) and policy implications that led to promote student-centred inquiry-based learning. The researchers realized that such a study cannot prove any outcome to be directly influenced by the programmes, hence impossible to justify the cause-effect relationships. Unlike longitudinal studies, these were only conducted retrospectively without randomly assigning the samples in 'treatment' or 'control' groups. The participants were also not subjected to research instruments. Hence the first part can only support the assumption made (Cohen, 2004; ILO, 2014) and in this study, it can be inferred 'whether the programmes being studied incorporated different strategies which resulted in objectives that led to dissemination of knowledge about ESD/EFA'.

On its own, a tracer study cannot provide a comprehensive picture. In addition the samples being interviewed may not be truly representative of the whole population. While there is always something to learn, it would be appropriate to question the potential for applying that learning to theory, practice and to policy since these studies focus on programme ideas undergoing development. It is possible that policy can only be built around information from more stable programmes (Cohen, 2004; ILO, 2014), such as the three programmes that were highlighted in this study (i.e., HVWSHE, CCIEM and SSYS).

Research Implications and Suggestions for Future R&D Activities

In this study, the idea of DR RED programme was evolved as results of researcher's experience involving in HVWSHE, SAW [as reflected in Appendix A Table A(2)] and SSYS programmes. More strategic planning should be made to deal with key questions such as 'What to do, for whom to do and how to excel', perhaps to consider including broader field of research and evaluation towards building new knowledge and high quality service (Armstrong, 1986; Cohen, 2004). Many lessons were learnt to improve the delivery/implementation of programmes. Firstly this study generated richness of data as concurred with the literature. Through the centre's initiative to build sustainable campus, each of these programme is different in terms of its target group (i.e., stakeholders mainly teachers and students), context, strategies, also methods used to trace former participants and their current status. In fact, SSYS congresses generated many creative ESD/EFA related project ideas and student delegates involved had ventured into science and technology related careers such as engineers, medical professionals and research scientists, some of whom are still in touch and being interviewed by the first author as reported in Ng (2002; 2005; 2012).

Apart from 'developing mixed methods and identifying measurable impact indicators considering cultural sensitivity and practicalities', 'ensuring accurate/complete record-keeping' is also suggested in literature (Cohen, 2004). Hence Southeast Asia Regional Capacity-enhancement Hub (SEARCH) was initiated to promote sustainable knowledge management system (Ng, 2010). The SSYS project output being archived in the e-forum of SP3ACEMAN also serves as rich source of information for the sharing of exemplary practices and dissemination of ESD concepts through investigative research (Ng, 2008; Ng & Baharulnizam, 2013; Ng, Mangao & Baharulnizam, 2014).

Moreover, the analysis of data collected from surveys and interviews also revealed the research implications that are worth pondering. Apparently many stakeholders who were interviewed felt that they were motivated to be the green ambassadors and learned tremendously from their experience involving in ESD/EFA related programmes as evidenced also in their outstanding green initiatives awards winning performances. Hence the future areas that could be exploited may include the opportunities for directions, challenges to support the advancement of youth development in ESD/EFA.

New domains of partnership that provides a repository for knowledge areas required to address the needs from SEAMEO perspectives for regional collaboration/partnership in youth development should be explored. Follow-up activities were the development of survey being piloted and administered during the 9th and 10th SSYS congresses (3rd to 7th March 2014 and 7th to 11th March 2016 respectively) to explore the delegates' inclination and attitudes towards the use of technology to enhance sustainable living through the teaching and learning of thinking skills, technology skills and life (i.e. work/survival/entrepreneurial) skills as aforementioned. Other activities as part of SEAMEO Borderless School [that was renamed LeSMaT (Borderless)] project to promote ESD and EFA were 'SAW curriculum

writing/editing workshops' (from 19th to 20th June and 1st to 3rd October 2014)[Appendix A Table A(2)] to prepare Open Educational Resources (OER) with sharing of exemplars being disseminated on-line.

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Appendix A

Table A

Tracking Milestones and Lessons Learnt for the Way Forward Incorporating Different Strategies for Dissemination of Knowledge about ESD through Research Projects, Books and/or Papers

	Green building & DR RED			**Sustainable knowledge management & social sustainability**				
	Sustainable Water Use	Waste Management	Pollution control	SEARCH SSYS	SEARCH forum SP3ACEMAN	SEARCH SpecP2E2	RECSAM or eLMS	FB official and event pages
S								
(1) Tracking milestones								
HVWSHE or **SEA WAVE**	Rain Water harvesting	Colloquia	Colloquia	N/A	Table 1 (e-portal)	Table 1 (e-portal)	Link with SEAMEO	SEAMEO Centres and RECSAM's official FB pages
(Echotrained project teacher/schools)	Rain Water harvesting campaign at school	Chief Minister Green Award (CMGA) 2013 MPSP('10,' 11)	Green School awards (2012,13)	Maths project presented in SSYS congress 3-7/3/2014	River Ranger project posted on e-forum sp3aceman.net	HVWSHE project uploaded e-SEAMEO	Learning Science & Maths LSM-07,09	
CCIEM or **SEA CLIMATE**	Rain Water Harvesting at centre	Setting Up 3 types recycling bins	Composting workshops	[Reports of progress on two portals accessible from URL: http://www.recsam.edu.my/search/P2E2/index.html]		Table 1 (e-portal)	[CCIEM Online course conducted in 2013 and accessible on URL: http://elearn.recsam. edu.my/]	
(Special project schools)	APN project involving schools from Malaysia, Indonesia, Thailand, Philippines and Lao PDR			[All project reports accessible from Aligaen (2011), Aligaen & Mangao (2012b); URL: http://www.recsam.edu.my/html/APN%20Report.html]				
SSYS	Refer Table 3			Table 1 (e-portals)	N/A		Index page and LSM 2011	[SSYS on FB https://www.facebook.com/groups/188900397742/]
(Pilot or project schools)	[Project schools won the following: (a) Best in scientific creativity, 2008 (b) Best research report, 2012, etc]			[SSYS projects accessible from: http://www. recsam.edu.my/ssys and archived on http://forum.sp3aceman.net/viewforum.php?f=4]				

Table B

Tracking Milestones and Lessons Learnt for the Way Forward Incorporating Different Strategies for Dissemination of Knowledge about ESD through Research Projects, Books and/or Papers

	Green building & DR RED			**Sustainable knowledge management & social sustainability**				
	Sustainable Water Use	Waste Management	Pollution control	SEARCH SSYS	SEARCH forum SP3ACEMAN	SEARCH SpecP2E2	RECSAM or eLMS	FB official and event pages
BORDERLESS school (i) thinking & ICT skills	A colloquium entitled 'Developing essential for sustainable living' was conducted on 19/4/2014			(i) [http://www.recsam.edu.my/search; http://forum.sp3aceman.net] (ii) [https://www.facebook.com/pages/SEAMEO-RECSAM/124118604272865?fref=ts and http://elearn.recsam.edu.my/]]				

					(iii) [http://www.recsam.edu.my/nizam%20TPD/Recsam_news_april_2013.pdf]	
(ii) life (work & survival) **D**isaster **R**isk **R**eduction **ED**ucation (DR RED)	[https://www.facebook.com/permalink.php?story_fbid=679241952093858&id=124118604272865&comment_id=7224549&reply_comment_id=7338776&offset=0&total_comments=15&notif_t=share_comment]				[Discussion on DR RED posted on SP3ACEMAN e-forum: http://forum.sp3aceman.net/viewtopic.php?t=62343 Details of the procedures to use e-forum available on: http://www.recsam.edu.my/lsm/index.htm Learning Science and Maths (LSM) e-journal (Ng et al., 2013)]	[DRR on FB https://www.facebook.com/events/1401275593457278/?ref_newsfeed_story_type=regular]
(Networked or project schools)	[http://www.openpraxis.org/index.php/OpenPraxis/article/view/104/69#.UpRRkoo7CXM.facebook]				[Networking activities http://www.recsam.edu.my/search/P2E2/index.html and http://ict.unescobkk.org/groups/telecollaboration-of-teacher-educators/]	
Science **A**cross the **W**orld (SAW)	(i) SAW curriculum writing workshop (19/6-20/6/2014) for all ESD related topics				[Networking http://www.recsam.edu.my/search/ http://www.scienceacross.org/ and https://www.facebook.com/groups/76236658623/]	[SAW on FB https://www.facebook.com/groups/108632725863761/]
Curricurulum workshops *(Project schools)*	SMSTSSS, SMKAlM, SMKPFS exemplary schools	SMKSN CMGA 2008	SMKSM exem-plary school	LSM article by Ng, Toh and Boey (2010)	(ii) SAW curriculum editing workshop (1/10-3/10/14) to design learning objects using 'Learning Activities Management System' (LAMS) and will be uploaded online as Open Educational Resources (OERs)	
Children's **N**ature **C**on – nected-ness (CNC)	(i) CNC module writing workshops in June and October				[Networking activities http://www.recsam.edu.my/search/P2E2/index.html]	Learning Science and Maths LSM-2006 [http://www.recsam.edu.my/lsm/2006/2006_5_NKT.pdf]
(Project schools)	(ii) Special project school: HVWSHE primary school				[Preview of research report accessible on URL: http://www.recsam.edu.my/html/ChildrenNature.pdf]	

Appendix B

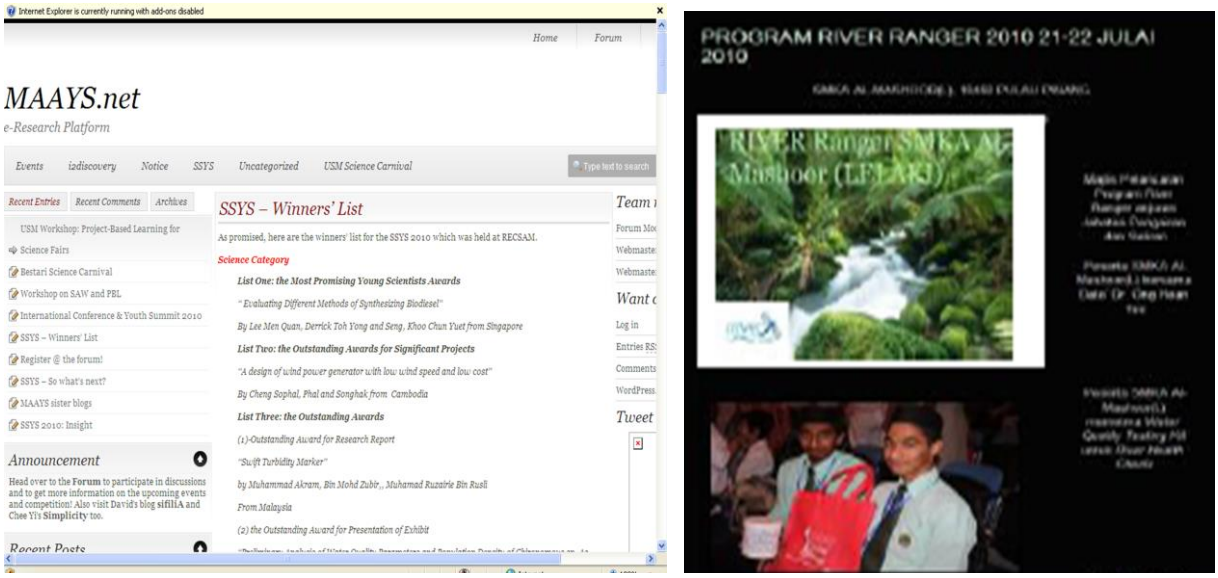

Figure A. Students guided by HVWSHE teacher won awards in SSYS and state competition [URL: http://maays.net/2010/03/13/ssys-winners-list/ and http://smkaalmahshoorriverranger.blogspot.com/].

Figure B. Rainwater harvesting project implemented in the HVWSHE exemplary school.