Development of Transdisciplinary Models to Manage Knowledge, Skills and Innovation Processes Integrating Technology with Reflective Practices

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ABSTRACT
This paper is part of a bigger research with three cycles of reflective studies to identify essential attributes in validating transdisciplinary models to manage innovation processes, skills training and human resource development through 'Learning Science/Mathematics Together' in a borderless world [LeSMaT(Borderless)] using technology. During the pilot phase or first cycle, the innovation processes of 'Knowledge, Thinking, Incubation, Inspiration and Development' are reported involving secondary learners participating in Problem-based Learning using Scaffolded Instruction (PBL-SI) approaches. These are supported by POSITIVE monitoring/evaluation rubric to guide them involving 'Planning with Objective/ organisation, Skills development, Information/ resource procurement, Training/transferring skills, Involvement/ incorporating Pedagogical-Content-Knowledge (PCK), emphasising Values/attitudes/ motivation and Evaluation/exchange/enrichment/ exposure'. The lessons learnt from the pilot phase anchored on sociocultural/constructivist framework were adapted in the second phase to facilitate LeSMaT(Borderless) using various sustainable blended learning platforms for managing knowledge, innovation processes as well as developing thinking, technology and life (work/survival/entrepreneurial) skills. In the subsequent phase, case exemplars are reported with highlights on recently implemented Smart PLS in-service skills training workshop to validate research instruments/models that promote scenario-based Education for Sustainable Living (ESL). Implications and future direction of research are also deliberated**.**

Keywords
Transdisciplinary models, Process integration technology, Reflective practices, Skills Innovations

1. INTRODUCTION
The unprecedented global challenges e.g. oil crisis, terrorism and disasters influencing world economy with impact on the livelihood are the concerns of many global citizens especially among the Malaysians who have suffered much recently on the issues such as price hike, recession and depreciation of currency exchange. Science educators have to rethink the ways to teach science/ maths with more transdisciplinary approaches to manage knowledge, skills and innovativeness as well as better prepare younger generation to face the increasingly challenging world integrating life (entrepreneurial/survival/work) skills. This is partly also because the 'Science, Technology, Engineering, Mathematics' (STEM) education has been given due emphasis by the government recently with the visions to produce critical mass of technology-based skilled workers.

1.1 Background and Rationale
In fact the success of a developing nation e.g. Malaysia depends much on the competencies, knowledge and skills of its people that are significantly affected by transformative educational systems supported by sustainable Blended Learning (BL) platforms in increasingly globalized world.

Developing 'culturally responsive student-centred pedagogical approaches supported by technology' as a mean of transformation is an important action taken by educators who constantly reflected on their own practices. Being an educator working in the leading Centre to promote Science and Mathematics education for sustainability in the SEAMEO region, the author recently experienced three stages of trialling the framework of transformative practices to develop transdisciplinary models in managing knowledge, skills and innovation processes. Science/mathematics pedagogical approaches were integrated and supported by sustainable e-learning platforms for professional development, student-centred learning and networking activities.

1.2 Aims and Research Questions
This study aims at identifying essential attributes of transdisciplinary science education model in managing knowledge, innovation process, skills training and human resource development through three cycles of reflective practices within the cyclical processes of 'plan-act-observe-evaluate-reflect' of action research protocols to be reported. Elaboration is made on authors' experiences in the piloting and implementation phases of developing transdisciplinary models as well as research instruments or research models to promote 'Learning Science and Mathematics Together' in the borderless world [henceforth abbreviated as LeSMaT (Borderless)] leveraging on various blended-mode technological tools and social learning platforms. The following are the Research Questions (RQs) identified:

(1) How could learners' higher order thinking (HOT) skills be enhanced through student-centred pedagogical approaches (e.g. PBL) with evidences of creativity/innovativeness and what are the procedures/processes that could be implemented?
(2) What are the features of transdisciplinary science education model supported by digital tools with exemplary practices in manageing knowledge and innovation process to reach out to wider audience?
(3) What are the areas that can be focused for the development of research instrument/model to facilitate the evaluation of thinking/technology/life skills training and human resource development leveraging on digital learning platforms?

2. METHODOLOGY

This reflective study employs the cyclical processes of "plan-act-observe-evaluate-reflect" [1, 2] using the protocols of Action research. Three activities including 'research, participation and action' were involved to seek the answers for the practical questions incorporating the features of "self-evaluative, collaborative, participatory and situational" involving the author with other collaborators in three phases. The cyclical processes or spiraling cycles included identifying problem, planning actions, implementing collection of observational and behavioral data systematically, reflecting on the data analysed as well as carrying out data-driven actions. Fact-finding or problem redefinition was also implemented to explore the results of the actions taken so that further planning and actions could be taken.

Through mixed-research activities incorporating collaborative inquiry and assessment/ evaluation techniques, data were collected and analysed using both qualitative and quantitative research methods. These include documentary analysis on project or learning output as well as archival records including publication and responses posted on e-forum or social learning platforms; classroom observation, interviews or focus group discussions, checklists and administration of survey questionnaires. Mixed-methods research was used within the stages of cyclical practices as the attempt to legitimate the use of multiple approaches in answering research questions. It is a better approach than restricting or constraining researcher's choices to collect and analyse data. This is because mixed-research is complementary, expansive, inclusive and pluralistic, but not limiting form of research. Indirectly it means that researchers should be creative to take an eclectic approach for selecting methods as well as thinking about and conducting the research [3-5].

3. ANALYSIS OF CYCLES OF STUDIES AND DISCUSSION OF FINDINGS

3.1 Pilot Phase or First Cycle of Study

During the pilot phase or first cycle of this study in response to Research Question (RQ) 1 'How could learners' Higher Order Thinking (HOT) skills be enhanced through pedagogical approaches (e.g. PBL) with evidences of creativity/innovativeness and what are the procedures/processes that could be implemented', various technology-enhanced activities were carried out involving problem identification and planning of data-driven actions. The promotion of HOT among secondary learners is an area of concern identified in response to the call for the need to have critical mass of thinking workforce in Malaysia that aspires to be a developed nation in the near future. An evaluative study was conducted to examine the effects of 'Problem-based Learning through Scaffolded Instruction' (PBL-SI) approach on HOT among groups of non-gifted secondary learners. A model was designed by the researcher incorporating the teaching of secondary science topic 'Water/Matter' through PBL-SI aiming at 'resolving water issues and managing waste to sustain community living' with brief findings as summarized in the following Figure 1 [6].

The researcher developed a model to promote HOT skills of learners through technology-enhanced PBL-SI approach supported by POSITIVE monitoring/ evaluation rubric. These involved '**P**lanning with **O**bjective/organisation, **S**kills development, **I**nformation/resource procurement, **T**raining/ transferring HOT skills, **I**nvolvement/incorporating Pedagogical-Content-Knowledge (PCK), emphasising **V**alues/ attitudes/motivation and **E**valuation/exchange/ enrichment/exposure' (or abbreviated as POSITIVE). For the sake of this study in response to RQ1, the analysis of data and discussion of findings will only be focused on the 'Training and transfer of HOT' component.

It was argued by [7] that PBL with minimal guidance was ineffective, so need to consider scaffolded instruction (SI) and factors to prepare students to think beyond classroom. Hence the study on a PBL-SI programme that enhance HOT among secondary non-gifted learners (comparing Non-PBL controlled group) aimed to bridge the knowledge-learning gap problem with research implications. In this phase of study, PBL-SI groups were presented with problem scenario using support tool guided by POSITIVE rubric while Non-PBL groups were taught through transmission approach. Several instruments were developed encompassing three main aspects to illuminate evidence or change of '*ability, achievement* and *aptitude'* as manifested by students participated in the PBL-SI study. One of the instrument, 'Fluid intelligence Test' (FIT) was developed during this phase involving two pilot studies to establish its validity and reliability.

FIT was a test of culturally independent or require culture-free mental efficiency, *i.e.* an example of 'aptitude' test to evaluate 'how quickly or easily the student will be able to learn in the future'. It was a type of psychometric test to evaluate learners' potential, the ability to solve new problems or the aspects of intelligence that involved the ability to see complex relationships and solve problems [8]. The questions raised in the items of FIT focus on evaluating the HOT aspects such as *creative thinking* (originality, flexibility, fluency with elaboration), *critical thinking* (identifying variables, analyzing relationship, comparing and contrasting), *logical thinking* and *reasoning skills* (choosing best solution logically with reasonable explanation of choice of response).

Two pilot studies that were conducted involved the first group [N_1=40 (pilot study 1)] and second group [N_2=84 (pilot study 2)] of students selected from secondary student samples of very high, medium and moderately low achievers (recommended by the school teachers based on their academic performance in school examinations). Consequently, all the HOT questions that were piloted during pilot study 2 were accepted based on the results of item analysis that showed computed good range of $0.2 \leq \rho \leq 0.8$ and $D \geq 0.25$ (where ρ=Index of difficulty and D=Index of discrimination). The internal reliability for the final version of FIT computed through Kuder Richardson using SPSS statistics software also showed good Alpha value kr_{21} = 0.9043. Fluid Intelligence Test' (FIT) was proven to be good tool [$0.2<\rho<0.8$, $D>0.25$] to differentiate fluid intelligence of numerous types of non-gifted learners, as well as a reliable test for the evaluation of students' fluid intelligence with great implications in educational settings as it has high discriminating power. Both (PBL-SI, Non-PBL) groups were administered with FIT. The findings revealed that higher percentage of PBL-SI male scored higher in post-FIT as compared to PBL-SI female who scored higher than Non-PBL. From 'cross-case, within-case and exemplary case' analysis of value-based practices [9-11], students' potentials in science activities were also identified. 'More/moderately successful students' had shown motivation and were involved actively in preparing projects for mini science fair, young scientist congress, project proposal competitions and e-learning.

The analysis of data also revealed the following five steps of fostering creativity through PBL-SI that were concurred with the literature, i.e. "Knowledge, Thinking, Incubation, Moment

of inspiration and Development" [12]. It was observed that generally the PBL-SI research samples were able to acquire diverse '***knowledge***' utilizing all the five senses through searching the literature from diverse sources of information that were relevant to their project with effective use of Open Educational Resourcs (OER) [*i.e.* '**I**nformation procurement' (or the first 'I') as required in the POSITIVE rubric]. They were given the '**T**raining' and encouraged to work in groups to '***think***' deeply as well as brainstorm ideas using graphic organizers such as concept map and fishbone diagrams that reflect the '**T**ransfer of their HOT' component. There were occasions when students were given opportunities to participate in '**E**nrichment' activities or involve in something unrelated to the problem, i.e. '***incubation***' period. But the resources they gathered were able to '***inspire***' them to prepare projects for mini science fair (by the end of 2008 in female school), research proposals for Magnificent Advancement of Young Scientists (MAAYS) 'i2discovery' proposal competition (between December 2009 to January 2010 by a few male students). Selected male students (from project team being illustrated as 'exemplary cases') had also participated in '***development***' of project ideas into useful and practical applications guided by More Knowledgeable Others (MKO) with '**S**kills' (scientific/ICT) enhancement activities.

The findings of the first cycle served as useful 'self-evaluative' feedback to improve the simplified model into a more transdisciplinary model that was used in the subsequent cycles for the management of knowledge, skills and innovation processes through 'collaborative and participatory' activities supported by e-learning platforms. These were the two of the four Action Research features that seek the answers for the practical questions as main focuses of this study.

3.2 Second Phase or Cycle of Study

During the second cycle of this study in response to RQ2 'What are the features of transdisciplinary science education model supported by digital tools with exemplary practices in managing knowledge and innovation process to reach out to wider audience', more comprehensive model was developed not merely focusing on Science PBL-SI activities. These include the teaching of Science concepts across other knowledge/subject disciplines such as Mathematics, Technology, Engineering, Economics, Environmental Education, Arts/Languages and Social Sciences. This was mainly due to the reason that the researcher was involved in developing and coordinating various technology-enhanced science/mathematics student-centred learning programmes for the SEAMEO region and beyond. Moreover, apart from involving in the development of curriculum to raise students' literacy and achievement for 'Programme for International Student Assessment' (PISA) 2015 and 2018 with emphasis on Mathematics/Science as well as Reading integrating Technology respectively, the researcher was also involved in training groups of trainers/trainees specializing in technology-enhanced science, mathematics and language teaching.

The components of '**I**nformation/resource procurement, **T**raining/transferring HOT skills, **I**nvolvement/incorporating Pedagogical-Content-Knowledge (PCK), emphasising **V**alues/ attitudes/ motivation and **E**valuation/ exchange/ enrichment/ exposure' in the POSITIVE tool validated during the first phase of study were emphasized in the second phase. As an off-shoot of the first phase of study, an on-line learning hub supported by e-learning portals was developed with potentials working with experts in SEARCH for future science and mathematics researchers. Among the sub-portals hyperlinked to 'Southeast Asia Regional Capacity-enhancement Hub' (SEARCH) include the 'Search for SEAMEO Young Scientists' (SSYS), 'Science across the World' (SAW) and 'Human Values-based Water, Sanitation and Hygiene Education' (HVWSHE) international flagship programmes, to name a few. The lessons learnt from the pilot phase anchored on sociocultural/constructivist framework were adapted in the second phase to facilitate the aforementioned sustainable

Blended Learning (BL) platforms for managing knowledge and innovation processes. The development of thinking, technology and life (work/survival/ entrepreneurial) skills among self-directed learners was also facilitated through digital tools and student networking social learning platforms such as Edmodo and 'Learning Activity Management System' (LAMS) to promote SEAMEO 'Learning Science and Mathematics Together' (LeSMaT) in the borderless world [or LeSMaT (Borderless)] as reported by [13-16].

Various research instruments were also developed for the monitoring and evaluation of the aforementioned technology-enhanced learning programmes hyperlinked to SEARCH. For example, an instrument namely 'Water Attitude Scale' (WAS) was developed as well as validated to monitor and evaluate learners' sustainable water use ethics [17, 18]. Another instrument namely Attitudes towards Use of Technology in Education for Sustainable Living (ATUTESL) was also developed and validated with an exploratory study reported on the role of ICT tools in science classroom anchored on learner's efficiency model [19, 20].

Four main curriculum topics were developed in series of workshops between 2014-16 and beta-tested for LeSMaT (Borderless) in line with the aspirations of 'Sustainable Development Goals' (SDGs) [21] and reported [22, 23]. These were prepared as BL modules for Open and Distant Learning (ODL) with opportunities for higher learning [24, 25] to facilitate Training of Trainers (TOT) who are advocates of Education for Sustainable Living (ESL) and could promote critical mass of thinking workforce emphasizing ESL. Numerous educational models were prepared to manage knowledge, skills and innovation processes integrating technology to promote ESL and Education for Sustainable Development (ESD) with research evidences reported. For example, the optimized use of BL platforms to monitor and evaluate disaster risk reduction education for curriculum topic 'Climate Awareness and Disaster Risk Reduction EDucation' (CADRRED) was reported by [26].

The report on fostering global citizenship through agro-environmental project by a local school focusing on 'Conservation and Wise Use of Resources' (ConWUR) was presented by [27]. The enhancement of essential skills of learners through values-based sustainable energy education for curriculum topic 'Sustainable Energy for All' (SE4ALL) leveraging on interactive BL tools was reported by [28] and [30]. The initiative to nurture sustainable water use ethics through emerging practices in Mathematics and Science classroom integrating BL platform was presented by [29]. The teaching and learning methods for Asian communities were redefined to inform policy changes through 'Telecare and Healthy Lifestyle' (TeleHeal) collaborative learning platforms by [31]. The following Figure 2 illustrates the interrelated connections of 'Science, Technology, Arts/language and Mathematics' (STEAM) hybrid model for the lauching of model rocket [32].

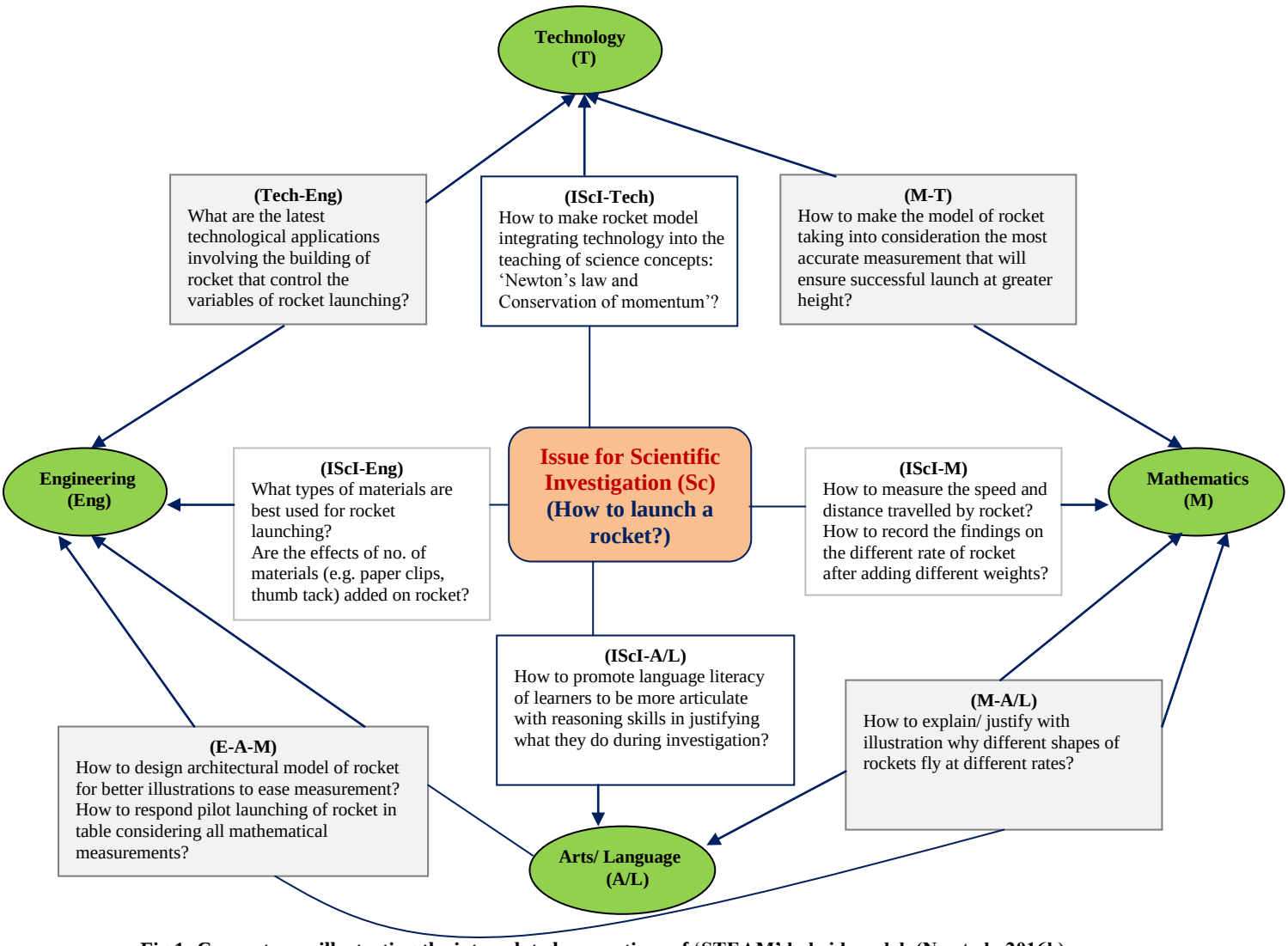

Fig 1: Concept map illustrating the interrelated connections of 'STEAM' hybrid model. (Ng et al., 2016b)

The teaching of transdisciplinary science through STEEEAMS model was also presented in a recent competition held at a local university [33].

3.3 Third Phase or Cycle of Study

During the third cycle of study, more comprehensive models were developed or refined from the previous models using problem/scenario-based approaches with the Action Research features of activities that were 'collaborative' and 'situational' in nature. These aimed at seeking answers for RQ3 'What are the areas that can be focused on for the development of research instrument/model to facilitate the evaluation of skills'. Subsequently, case exemplars were reported with highlights on the recently implemented Smart PLS in-service skills training workshop to prepare research instruments and/or models that could further promote scenario-based ESL with management of knowledge, skills and innovation processes integrating technology.

The components outlined in the POSITIVE tool validated during the first phase and adapted in various curriculum development or R&D activities in the second phase of study were revisited. Special emphasis was made on areas of '**S**kills development; **T**raining/transferring HOT skills; emphasising **V**alues-based pedagogical approaches and **E**valuation/exchange/enrichment/ exposure'. During the last workshop conducted in October 2016 to revise ODL modules for CADRRED, ConWUR, SE4ALL and TeleHeal, groups of participants from diverse background who are practising/expert teachers, educators and researchers were given an overview the use of statistical software packages. The author was the coordinator and facilitator in collaboration with an expert from a local university. The participants were given the exposure on the basic steps of using SPSS, Structural Equation Modelling (SEM) and Smart Smart Partial Lease Square (PLS) to perform data analysis as well as get more out of the data they possess by using inferential statistics with interpretation of data in a manner relevant to their research objectives.

More specifically, the LeSMaT curriculum editing workshop participants were given special tasks to explore the development/validation of instruments and model through application of PLS in SEM (or PLS-SEM) for future R&D activities involving LeSMaT in the borderless world. The participants were divided into three groups to revisit three survey instruments and explore the development/validation of survey questionnaires as well as conceptual/research model using Measurement Model (MM) and Structural Model (SM) in Smart PLS statistical tools with input given in comparing

two models. These include objectives, brief features of PLS-SEM, minimum number of samples and items required, sample surveys/models and target output for LeSMaT.

This first targetted output of this workshop was to explore the development of validated 'Water Attitude Scales' (WAS)[18] instrument using MM of PLS-SEM for future R&D activities to be conducted in 2017 with reference made on the curriculum prepared in TeleHeal module. The second targetted output was to explore the development of validated 'Survey on Core Skills for Work Development Framework' as reported by [33] using MM of PLS-SEM for further R&D activities incorporating the curriculum introduced in ConWUR module. The third targetted output was to explore the development of validated 'Living Values Instruments' (LVI) to promote ESD and ESL [30, 34, 35] using MM of PLS-SEM for further R&D activities with reference made on the curriculum prepared in CADRRED module. The fourth targetted output was to explore the development of structural models to promote Values-based Sustainable Energy Education (VABSEE) and ESL for R&D incorporating the curriculum introduced in SE4ALL module.

Before further input given on various aspects of Smart PLS statistical tools in comparison with SPSS and SEM/AMOS, the participants were introduced two important indicators that could better guide the development of models, *i.e.* Reflective Indicators (RI) and Formative Indicators (FI). They were requested to brainstorm ideas on how the instrument items could fit either into RI or FI prior to the development of Smart PLS models. The analysis of the learning output revealed that they were able to differentiate these indicators by showing the arrow pointing out from the construct as 'Reflective Indicator' (RI) and pointing towards the construct as 'Formative Indicator' (FI) (Figure 2).

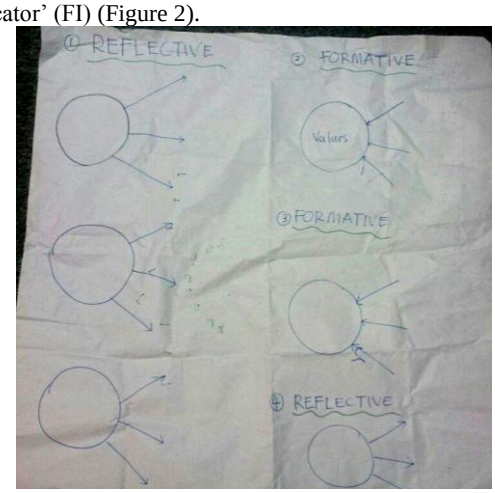

Fig 2: Learning output illustrating Reflective Indicators (RI) and Formative Indicators (FI).

When analyzing the instrument 'Attitudes Towards Use of Technology to Enhance Sustainable Living' (ATUTESL), the item RU1 'I always surf Internet for the latest information on Sustainable Development' is the first RI of the first construct 'Resource Usefulness' (RU)(refer the left diagram of the following Figure 3). When analyzing 'Water Attitude Scale' (WAS), the negative item 'It is alright to keep tap water running when brushing teeth' is the RI of the construct 'Water Attitude' (Figure 4).

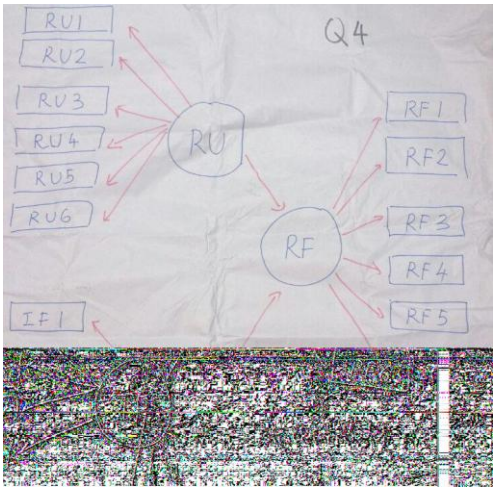

Fig 3: Learning output of Smart PLS workshop to prepare models illustrating Reflective Indicators (RI)

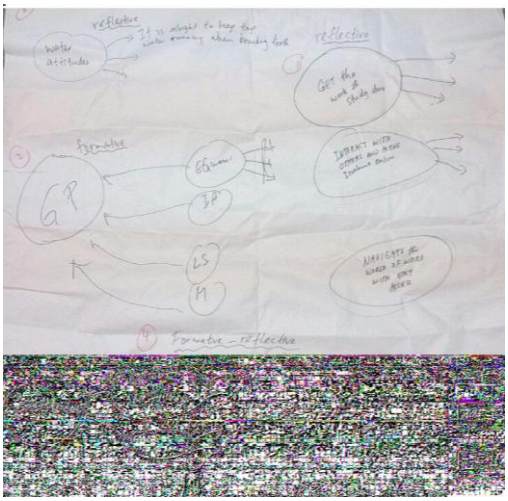

Fig 4: Learning output of Smart PLS workshop to prepare models illustrating Formative Indicators (FI).

4. CONCLUSION AND FUTURE DIRECTION

This article illustrates the reflective practices of the author on the development of transdisciplinary models supported by sustainable digital platforms for professional development of educators and networking of students with management of creativity/innovative processes as well as enhancement of technology, thinking and life (work/survival/entrepreneurial) skills.

4.1 Implication and the Way Forward

During the first phase of study, a model was developed to enhance students' HOT skills through blended-mode PBL-SI approach supported by POSITIVE monitoring/evaluation rubric and evaluated by various research instruments such as validated FIT as reported. PBL-SI groups were presented with problem scenario in support tool guided by POSITIVE rubric while Non-PBL group was taught using transmission approach. The findings revealed the effectiveness of POSITIVE monitoring/evaluation tool to promote thinking skills of PBL-SI learners. These include their enhanced FIT and evidences of 'knowledge, thinking, incubation, moment of inspiration and development' processes for innovation that concurred with the findings from the literature. Hence, various follow-up R&D activities were conducted with research

findings reported [36-39]. The author's interest was also stimulated for further development of transdisciplinary models to manage knowledge, skills and innovation processes in the subsequent cycles of reflective studies, also partly due to the increased roles of the author involving in the training of trainers/trainees specializing in technology-enhanced science, mathematics and language teaching. In addition, the experiences gained from this reflective study stimulated the idea of spearheading the EnTeaCH programme aiming to provide teachers with opportunities for Continuing Professional Development (CPD) such as the pursuit of postgraduate degrees in higher learning institutions. EnTeaCH is the acronym of programme initiated aiming at "**En**hancing **Tea**chers' **C**ontinuing-professional-development (CPD) with **H**igher-learning-opportunities" in collaboration with higher education institutions especially those with Open and Distant Learning (ODL) mode of delivery. It is envisioned to be an important pathway to form a pool of educators/trainers for ESD and ESL related issues.

In the advent of digital era, the use of technological tools in the delivery mode for sharing of knowledge and dissemination of information can expedite the process of Training of Trainers (TOT) towards achieving the aspired goals of ESD/ESL and Education for All (EFA) as reflected in the education agenda of SEAMEO and MOE Malaysia. It is hoped that teachers or educators in the SEAMEO region will be better prepared with input given on the most current technology-enhanced pedagogical approaches to facilitate student-centred learning activities in line with the SEAMEO seven priority areas [40]. It is also expected that these trainers could serve as advocates for further training of critical mass of educators and learners who are well verse in ESD/ESL issues with resiliency in facing emergencies. In fact the findings of this study concurred with the research evidences of other researchers who evaluated the effectiveness of ICT to promote technology-enhanced learning [41, 42]. In the study by [43] to link students through project-based learning via ICT integration, it was also acknowledged that global issues, especially those concerning the environment, will only be resolved by international agreement. Yet different societies have their own perspectives and priorities on matters such as water quality or energy use. It is only by understanding these differences that practical and acceptable solutions could be found. Through spiraling cycles of identifying problem, planning actions, implementing collection of observational and behavioral data, the author also experienced self-evaluative (Phase 1), participatory (Phase 2), collaborative (Phase 2, 3) and situational (Phase 3) reflective practices working in collaboration with various experts/stakeholders to improve the models for trialling and implementation. It is hoped that more improvement of the models could be seen with more exemplary practices in the subsequence phases.

4.2 Limitation and Suggestions for Further Studies

The researchers realized that there are still much constraints faced to implement the aspired technology-enhanced transdisciplinary model partly due to digital divide that did not allow full implementation of curriculum through ODL mode. The compact curriculum to be delivered within short timeframe as practised in many countries also did not permit the teachers to practise this model to manage innovation processes of learners. Longer timeframe is actually needed to pilot the instruments among secondary learners with validation and analysis of data to be completed using Smart PLS statistical tool, with sample structural model presented as shown in Figure 5.

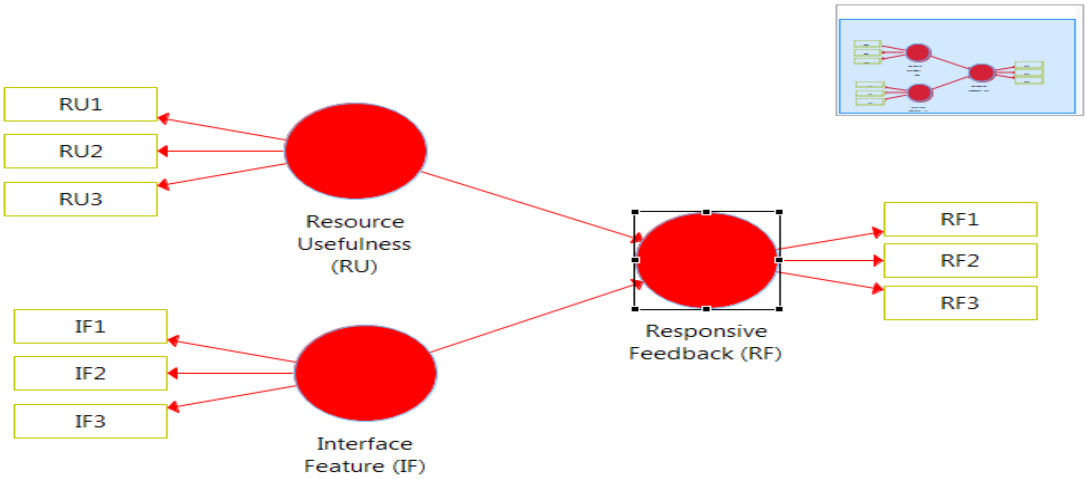

Fig 5: Sample structural model using Smart PLS statistical tools.

In addition, seeing the increasing global threats faced that are related to human's moral values such as terrorism, more R&D activities should be conducted incorporating values-based BL platforms with sharing of exemplary practices as well as exchange of findings among the stakeholders in the SEAMEO region and beyond. In order to achieve the aspiration of stronger SEAMEO community, some kind of cross-cultural ASEAN values could be incorporated during the final revision of ODL curriculum to promote ESD/ESL and Education for All (EFA). These values-based programmes should be incorporated ongoingly to cultivate lifelong, self-directed/self-paced/self-accessed learning among the learners especially on the aspects of thinking, technology and life (work/ survival/ entrepreneurial) skills development. The stakeholders in the educational community should be given more opportunities and empowerment of skill development as well as capacity building in the Community of Practice (CoP) as advocated by [44]. More workshops will be conducted for refinement of curriculum and development of research models with more training opportunities to be explored for teachers' Continuing Professional Development (CPD). These are aimed at responding to call for enhancing teachers' quality, learners' competence/capabilities as reflected in one of the objective to develop framework for 'global competence

designed to measure students' awareness of the interconnected world and their ability to deal with its demands' [45].

Moreover, being the chief editor of the centre's BL publication and associate editor for the online journal, the author has recently reviewed and advised the publication of research-based articles as well as lesson plan exemplar to guide teachers practising science/mathematics teaching through transdisciplinary model. Among the recently completed publications included [32, 33, 46]. The author also explore various digital platforms and keep updated with the latest trends of BL portals that promote the aspired skills development. An e-portal (8net) was recently found to be useful to promote thinking, technology and life (work/ survival/ entrepreneurship) skills in which apart from publishing articles related to global issues that raise awareness of online readers, any learner could also practise creative writings by joining with free membership through this URL: http://goo.gl/fcbabg. The types of essays published online include 'Marketing, Funny/Humour, Reticulocyte, Insider Secrets, Global opportunities, Characters, Fashion, Home, Soul, Real estate, Entertainment, Travel, Health and fitness, Science and technology, Immigration, The law, Current affairs, Investment, Financial, Education, Life and Others'. Completed article (in Chinese and/or English languages) could be uploaded onto the platform for consideration of publication with opportunity for self-directed income generating activities and entrepreneurship. This platform was piloted since end of last year and found to be effective with potential for future R&D activities in line with the focus of this study to manage knowledge, innovation processes as well as enhance thinking, technology and life (work/survival/entrepreneurship) skills through transdisciplinary science education integrating knowledge in mathematics/technology/engineering/ environmental economics/arts and language/social sciences, to name a few.

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