

Integrating Indigenous Knowledge and Skills in Technology-Enhanced Science Project-Based Activities: Exemplars, Issues and Challenges

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Abstract

The world is full of abundant resources that are untapped. This is especially pertinent during the pre-digital era in the countries that emphasize on agriculture including the products that are produced by indigenous groups. This study aims at exemplifying methodologies with evidences of transfer of knowledge and enhanced thinking/technology/life skills among science learners and community members involving indigenous groups through technology-enhanced learning (TEL) project-based activities (PBA) and/or other strategies in selected schools in Ubon Ratchthani, Thailand. Literature review is also made on trans-disciplinary approaches and other cases or lessons learnt. Mixed-research methods were used involving case study and documentary analysis on the output of collaborative inquiry through technology-enhanced PBA. The analysis of document was made on archival records, portfolios including journals and diagrams/photos of activities posted on Edmodo e-platform sub-themes entitled 'Conservation Wise Use of Resources' (ConWUR) and 'Learning Transdisciplinary Science integrating Mathematics/Arts-Language-Culture/Engineering-Environmental Education-Economics/ Technology' (LearnT-SMARET). In addition, videos recorded on the technology-enhanced science PBA integrating indigenous knowledge and skills were also analysed. The findings revealed that among the useful indigenous knowledge and skills that could be transferred through TEL include preservation of food, producing agricultural products, finding crabs in rice fields, etc. The issues and challenges addressed in this study as well as implication and numerous further research activities that could be implemented are elaborated. The administration of on-line survey entitled 'Attitudes towards the Use of Digital-tools and Application of Philosophy of Sufficient Economy' (ATUDAPOSE) through Google form is also discussed.

Keywords: Exemplary practices; Project-based Activities; ICT integration; Primary science curriculum; Indigenous knowledge and skills; Technology-enhanced learning

Introduction

Background and Rationale

Our world is full of abundant resources that are untapped. This is especially pertinent during the pre-digital era in the countries that put major emphasis on agriculture and agro based industry including the products by indigenous groups. However, the advent of digital era has led to the increasing awareness on the wise and critical use of scientific, Information and Communication Technology (ICT) that are essential to enhance the quality and reach of Education for All (EFA). Hence, with an increasing demand of food supply due to population growth, it is worth re-thinking and ponder if more strategies could be implemented in terms of trans-disciplinary knowledge transfer and skills training in pertinent areas to produce younger generation practising self-directed/self-paced/self-accessed or independent learning culture anchoring on the philosophy of sufficiency economy that is currently the common practice in Thailand.

Focus and Objectives of Study

This paper aims at exemplifying methodologies with evidences of transfer of knowledge and enhanced thinking/technology/life skills among primary science learners and supporting community members involving indigenous groups through technology-enhanced learning (TEL) project-based activities (PBA) and/or other strategies in selected schools in Ubon Ratchthani, Thailand. Literature review is also made on trans-disciplinary approaches and cases learnt from Malaysia as guide for the study framework.

The following research questions are identified as focus of study:

1. What are the essential aspects of self-directed/-paced/-accessed project-based activities (PBA) with curriculum themes that support the philosophy of ‘sufficient economy’?
2. How could PBA supported by digital tools and e-platforms address the issues and challenges of trans-disciplinary knowledge transfer and thinking/technology/life skills training in pertinent areas to produce younger generation practising self-learning culture?
3. Are there exemplary practices integrating knowledge and skills among primary science learners from diverse backgrounds including indigenous groups showcasing the essential features of technology-enhanced PBA in support of philosophy of ‘sufficient economy’?

Literature Review

Education is the basic holistic growth of younger generation and people to balance both the body of knowledge based on moral consciousness and practise the noble value of global citizenship. In the digital world with availability of technological tools, much transformation that is largely science/technology driven was seen to take place swiftly at an unprecedented pace. Hence, developing countries should leverage on the available technological tools to enhance capacity building through student-centred learning approaches in trans-disciplinary science education in order to shape and sustain their nation’s long-term development involving citizens from diverse backgrounds including the indigenous groups.

Indigenous knowledge and skills in trans-disciplinary technology-enhanced learning

Humanity in the 21st century faces various unique global challenges that are complex in nature. The developing nations need critical mass of scientific and technologically literate citizens who are aware of the issues and challenges related to environment and society such as health care, conservation of numerous resources, climate change issues, to name a few. All these also require sound solutions to be addressed in Science, Technology, Engineering and Mathematics (STEM) education (Ng et al., 2016). Hence it is timely to promote STEM literacy for trans-disciplinary teaching that enhances critical thinking skills and imaginative solutions (Kidman, 2017; Sayed, 2017).

Truly global challenges require ‘trans-disciplinary’ methods in which knowledge and expertise cross traditional disciplinary boundaries (including knowledge from the indigenous groups) between science and the societies that it should serve (Sayed, 2017). Indigenous means originating or occurring naturally in a particular place, sometimes is also being referred to something or someone who is native to an area. Indigenous people or things belong to the country in which they are found, rather than coming there or being brought there from another country (Collins, 2018; Oxford, 2018; Yourdictionary, 2018).

The idea of transdisciplinary literally means beyond all the disciplines but connected to all the disciplines by a unifying issue or topic of inquiry (Discovery Education, 2018; Nicolescu, 2018). Digital technologies and open access platforms are powerful in providing novel methods to collect, curates and communicate information to help cross the boundaries between science and society (including indigenous groups). The development of useful knowledge bases through science/technology related training that are trans-disciplinary can help to maximise the potential of science in order to achieve the aspiration to produce high quality research and innovative products that can create impact in the society (Sayed, 2017). Such training should begin from an early stage and students should be empowered with opportunities for lifelong blended-mode learning to develop essential skills that include thinking, technology/communication and living (work/entrepreneurship/survival) skills.

Blended learning (BL) was identified by the American Society for Training and Development as one of the top ten trends to emerge in the knowledge delivery industry, hence became a buzzword in academic and corporate settings in the recent years in the digital era (Graham, 2004; Rooney, 2003). According to Pannen and Riyanti (2008), ‘blended/hybrid’ learning involves the blending of online and face-to-face (F2F) delivery. Substantial (30%-79%) proportion of content is delivered online, typically uses online discussions and has some F2F or off-line meetings. BL was broadly defined to encompass virtually all types of learning systems that involve multiple instructional methods and delivery media (Graham et al., 2003, as cited in Graham, 2004). Examples of commonly used tools in BL platforms are Web 2.0 tools that are the new wave of innovation in teaching and learning of science which allow students to do collaborative learning with enhanced motivation. A study by Alan (2010) highlighted that Middle East countries such as Israel, Saudi Arabia, United Arab Emirates and Qatar have made substantial investments in web-based learning and concluded that students were motivated by Web 2.0 tools. Blog is an example of Web 2.0 tool used as a Learning Management System (LMS) where students can download resources from various websites, give feedback to teacher’s contents, prepare digital portfolios, share their ideas, to name a few. Even an online questionnaire/test/quiz can be developed (Amold Nicholas, 2010).

Project-based Activities with Philosophy of Sufficient Economy: From Policy to Practice

Previous researches literatures revealed that the empowerment of STEM related studies in the advent of digital era could be implemented through four different approaches, i.e., pre-professional training as well as utilitarian, citizenship/democratisation and cultural/intellectual purposes (Bull, Gilbert, Barwick, Hipkins, & Baker, 2010). All these skills could also be developed through student-centred cooperative learning activities such as Project-based Activities (PBA) and Problem-based Learning (PBL) supported by blended-mode activities in digital platforms.

Project-based activities (PBA) offer a wide range of benefits to both students and teachers as well as for capacity building in educational settings to promote independent lifelong learning skill that is an important aspect identified in most of the training providers to enhance ‘capacity building’ of the stakeholders. ‘Capacity building’ can also include other actions and broad range of approaches to improve non-profit effectiveness in addition to its offer for training as well as Research and Development (R&D). For example, it is an important aspect to grant/manage operating/development funds, provide coaching, and support collaboration with other non-profits, to name a few. Increasing awareness was also seen in the recent years to use ICT as a tool for ‘capacity building’ as reflected in the ‘United Nations’ Sustainable Development Networking Programme’ (SDNP) (McNamara, 2008).

A growing body of academic research supports the use PBA in school to engage students, reduce absenteeism, boost cooperative learning skills, and improve academic performance. In Thailand, this PBA approach is widely used in schools in support of the philosophy of Sufficiency Economy brought forth by the beloved Majesty the King who was inspired by crisis on national economic and social problems in the past. The philosophy of Sufficiency Economy serves as the guiding principle to manage the nation’s call for sustainable economy. Since its inception, all government agencies have been tapped for its dissemination and application.

The Ministry of Education in Thailand has established a policy to drive the philosophy of Sufficiency Economy through education. In particular, the core curriculum of the Basic Education Act 2008 defines desirable Article 5 of the 8 questions is “self-sufficient”. The Ministry of Education (2011) has set the following guidelines for the Philosophy of Sufficiency Economy to education in schools as a way of teaching:

- 1) The management of educational institutions should provide an environment that is conducive to learning sufficiently. A corporate culture should be created with the use of sufficient resources being cultivated as a way of life including community relations;
- 2) Learning courses that should be a standard learning class;
- 3) Development of the students' guidance should be provided with counselling services; and
- 4) Almost all teachers should have teaching project. The public mental activity should be provided on participation.

Methodology

Mixed-research method or ‘mixed-method’ research was used involving case study and documentary analysis on the output of collaborative inquiry through technology-enhanced PBA. The researchers deemed it wise to conduct this study to introduce the PBA approach that was prompted by the nation’s wholehearted acceptance of the nation’s monarch’s philosophy as well as the recognition by the school on the importance to implement this philosophy to develop students' thinking processes and to cultivate moral values among younger generation.

‘Mixed-method’ research was selected as research design to explore the framework and examine the essential features technology-enhanced PBA anchored on the philosophy of sufficient economy. This type of research offers great promise for the authors as practising researchers who would like to see their methodologies described, hence developing techniques that are closer to what they actually use in practice. It is an attempt to legitimate the use of multiple approaches in answering research questions, rather than restricting or constraining the particular research choices. It is inclusive, complementary and expansive, i.e. researchers should be creative to take an eclectic approach for method selection, data collection and the conduct of research (Creswell, 2005; Johnson & Onwuegbuzie, 2004).

Data collection activities involved documentary analysis, interview and Focused Group Discussion (FGD) in 3 phases, i.e. Data reduction; Data organization and Data interpretation. The samples or participants (who were co-researcher/informants) for the interviews were selected from 5 schools, i.e. 3 small schools and 2 large schools. Out of 950 student population in the school, 855 (90%) are students from indigenous groups. There were 25 teachers (5 each in participating schools) who were identified as ‘Co-Researcher Teacher’ (henceforth abbreviated as CRT). Other samples included 5 Directors who were named as ‘Co-Researcher Director’ (or CRD) and 25 students who were identified as ‘Co-Researcher Students’ (or CRS) (of whom 5 of them were from large schools and 20 from small schools).

In this study, the ‘Mixed-method design matrix’ was chosen with ‘Dominant status in paradigm emphasis and Concurrent time order decision’ (Creswell, 2009, 2012; Johnson & Onwuegbuzie, 2004) focusing mainly on descriptive and exploratory qualitative research design such as case studies on exemplary practices, interviews and documentary analysis. The ‘Type 4’ multiple-case design and embedded (i.e., multiple units of analysis) is chosen using mixed-mode of both qualitative and quantitative data analysis in case studies (Yin, 1994, 2004). The analysis of document was made on archival records, portfolios including journals and diagrams/photos of activities posted on Edmodo e-platform sub-themes entitled ‘Conservation Wise Use of Resources’ (ConWUR)’ and ‘Learning Trans-disciplinary Science integrating Mathematics/Arts-Language-Culture/Engineering-Environmental Education-Economics/Technology’ (LearnT-SMArET). In addition, videos recorded on the technology-enhanced science PBA integrating indigenous knowledge and skills were also analysed.

Data Analysis and Discussion of Findings

This section analyses and discusses findings in response to Research Questions (RQs) 1 to 3.

Essential Aspects of Self-Directed PBA with Curriculum Themes on Sufficient Economy

In response to RQ1 “What are the essential aspects of self-directed/-paced/-accessed project-based activities (PBA) with curriculum themes that support the philosophy of ‘sufficient economy’”, the current educational practices that promote PBA culture among primary schools in Thailand were analysed. The following Table 1 illustrates the summary of ‘the curriculum themes that were identified to promote PBA and expected output’ based on the interview findings from co-researchers, i.e. 2 school Directors, one teacher and 8 students.

Table 1

Essential Aspects of Project-based Activities with Curriculum Themes and Expected Output

No.	Theme	Focus areas	Essential aspects involving PBA via ICT	Expected output
1	Agriculture	Animal raising, crop growing, farming	Construction of products in which students tackle real life problems by designing products or artifacts both individually and in groups.	Concrete agricultural products or artifacts
2	Handicrafts	Garment making, flower arrangement & design, food preservation	Construction of products in which students tackle real life problems by designing products or artifacts both individually and in groups.	Clothes fixing; flower inventing; food producing and cooking
3	Investment/ Marketing	Selling products and study how to calculate the balance cost between capital & net profit	Research project in which students have to attempt to respond in varying views with regards to question or problem posed by teachers as guide for research. Institutional visits or field trips are conducted in and around the community to interview experts or resource persons.	Brochures for marketing; Graphs of analysis; etc. Written reports or reflective journals
4	Skill Development	Thinking/ technology/ life (work/ survival/ entrepreneurial skills)	Technology-enhanced Learning (TEL) activities on social learning platforms (e.g. Edmodo) including written reports prepared in light of open-ended question. Production of media in which questions stem from sources such as online game-learning, production of audio and video clips to be viewed by various audiences.	Brochures designed using digital tools, e-forum posts, etc. Media product including audio and video clips, etc.
5	Self Development	Has direct experiences, systematical working, be good leader and follower and self audit/analyze	Research project and/or written reports prepared in response open-ended question for self-development Institutional visits or field trips are conducted in and around the community to interview experts or resource persons.	Written reports or reflective journals Written reports or reflective journals

PBA using ICT that Addresses Issues and Challenges of Transdisciplinary Knowledge Transfer and Training with Evidence of Enhanced Thinking/Technology/Life Skills

This section analyzes findings in response to RQ2: “How could PBA supported by digital tools and e-platforms address the issues and challenges of transdisciplinary knowledge transfer and thinking/technology/life skills training in pertinent areas to produce younger generation practising self-learning culture?”

The researchers were interested to find out what were the issues, challenges and constraints encountered by the teacher in terms of PBA. Interviews were conducted among 6 CRT and 4 CRS who shared experiences on the various constraints in the practice of PBA. These experiences are organized into the following aspects:

- 1) Lack of support from school authorities. The school director (principal) does not allocate enough funds for project materials and staff development.
- 2) Students have difficulty with the process of inquiry.
- 3) Time constraints.
- 4) Not enough time to facilitate the full PBL projects.
- 5) Lack of competency to integrate ICT in PBL Lack of adequate technological tools and limited scope of cognitive technological knowledge.

The following are some of the feedback on how were these constraints been addressed.

...The school has allocated funds for equipment and infrastructure and laboratories equipment and materials that will facilitate the completion of PBL project. Students and teachers were involved in the training program to train in self-directed learning and problem solving methods such as inquiry, art of questioning, fundamentals of research. Promote independent study on PBL time....

(Interviewee: CRDA)

The following are the summary of findings in response to the extent of ‘how the constraints been addressed’:

- ✓ Theme1: School Directors, Students and Teachers are more engaged in the activity because they have support on technology aspect of PBL have cleared direction towards end product.
- ✓ Theme2: Students are given more time to hone their skills.
- ✓ Theme3: Schools have reduced class size to provide more involvement and participation from all student and easy to manage lessons.
- ✓ Theme4: Students have more time to carry out projects dealing with world view and real life situation in recognition of the King’s philosophy on Sufficiency Economy.

Documentary analysis on the output and interview findings were also analysed based on the responses from the co-researchers including two school Directors, five teachers and one student who shared their experiences about the efforts of the school in developing students with various skills through PBA way. The following Table 2 illustrates the summary of some of the findings extracted from interviews, observation and documentary analysis.

Table 2

PBA Integrating ICT with Evidences of Enhanced Thinking/Technology/Life Skills

No.	Theme	Transdisciplinary knowledge/skills transfer	Thinking skills	Technology skills	Life (work/survival/entrepreneurial) skills
1	Agriculture	Plant and animal life	Investigate plants and animals in local environments; be aware of those in wider environments	Students share their output on social learning platforms e.g.	Students were able to demonstrate skills such as wise use of resources by recycling.
2	Handicrafts	Science and the environment	Investigate positive and negative effects of human activities on environments	Edmodo, FB, etc.; also using digital tools to draw, etc.	Making low cost materials or handicrafts or agricultural products for sale, to name a few.
3	Investment/Marketing	Number/Measurement	Help students develop creativity and the ability to think, communicate, and solve problems	Help students understand and acquire basic mathematical concepts and computational skills	Enhance students' lifelong learning abilities through basic mathematical knowledge

Under the themes 'Skill development' and 'Self-development', the following Table 3 lists the identified skills that were analysed from the interview and observation findings:

Table 3

Thinking Skills and Life Skills Developed After Participation in PBA

Skills	Examples
<p>Thinking</p> <p>Decision making</p> <p>Students think about their choices before making a decision.</p> <p>Students think about what might happen because of their choice.</p> <p>Students are happy with the choices that they make.</p> <p>When Students need to, they ask an adult for help in making a decision.</p>	<p>Making wise choices for healthy lifestyle</p> <p>Students choose healthy snacks like vegetables and fruits, cheese or peanut butter.</p> <p>Students wear a safety helmet when riding a bike, skateboarding or rollerblading.</p> <p>Students talk to someone when they are upset or scared.</p> <p>Students are aware of the importance of exercise and like to play outside everyday.</p>
<p>Life</p> <p>Wise Use of Resources</p> <p>Students recycle at home or at school.</p> <p>When students get money, they save some of it.</p> <p>Students make time for doing their homework.</p> <p>Students clean their room without their parents reminding them.</p> <p>Students pick up litter when they see it lying around.</p> <p>When making a project Students only take the things they need.</p>	<p>Self-directed/self-motivated/self-responsible</p> <p>Students follow a schedule for doing homework.</p> <p>Students do what they say they are going to do.</p> <p>Students go to an adult and ask for help solving a problem.</p> <p>Students take care of their things.</p> <p>Students ask for permission before they use other people's things.</p> <p>Students wait for their turn when doing an activity.</p>
<p>Others</p> <p>Communication</p> <p>Students listen when someone is talking to them.</p> <p>Students tell people how they feel when people hurt their feelings.</p> <p>Students apologize when they are wrong.</p> <p>Students get along with people.</p> <p>Students ask for help if they do not understand something.</p>	<p>Flexible thinking to accept differences</p> <p>Students would play with kids who are different than them.</p> <p>Students would have friends who are different than them.</p> <p>Students would invite a friend over to their house to play who is different than them.</p> <p>Students let others play with them even if they are not very good at the game.</p>

Exemplary Practices Integrating Knowledge and Skills among Primary

This section reports on data analysis in response to RQ3: “Are there exemplary practices integrating knowledge and skills among primary science learners from diverse backgrounds including indigenous groups that showcase the essential features of technology-enhanced PBA in support of philosophy of ‘sufficient economy’?”

The analysis of findings revealed that among the useful indigenous knowledge and skills that could be transferred through TEL (Figure 1 to Figure 4) include food preservation, producing agricultural products, finding crabs in rice fields, etc.



Figure 1. Printscreens of youtube video link posted on ‘ConWUR’ sub-portal.



Figure 2. Printscreens of youtube video link posted on ‘LearnT-SMArET’ sub-portal.

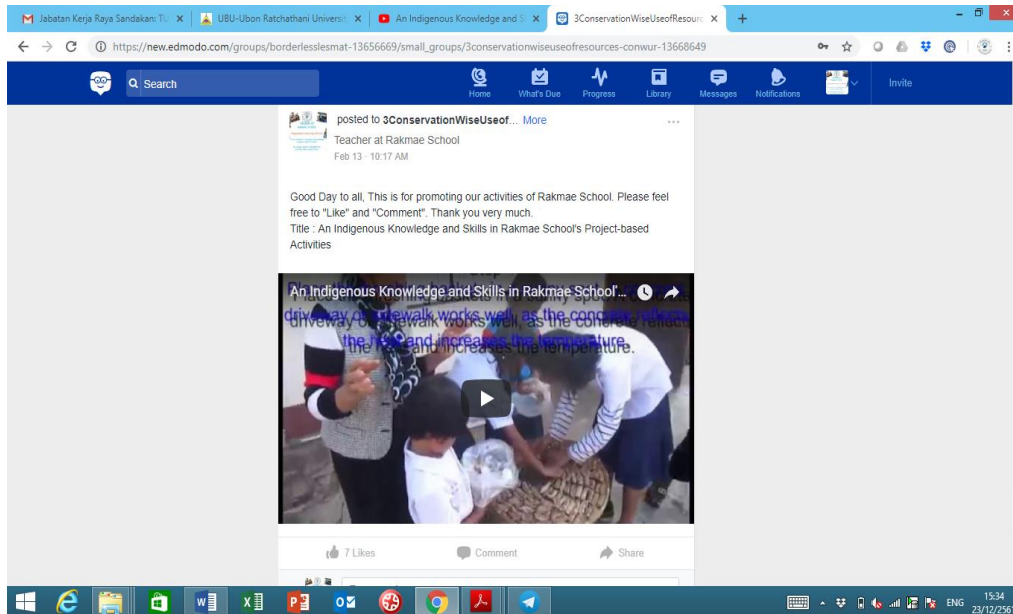


Figure 3. Printscreen of students’ PBA output posted on ‘ConWUR’.

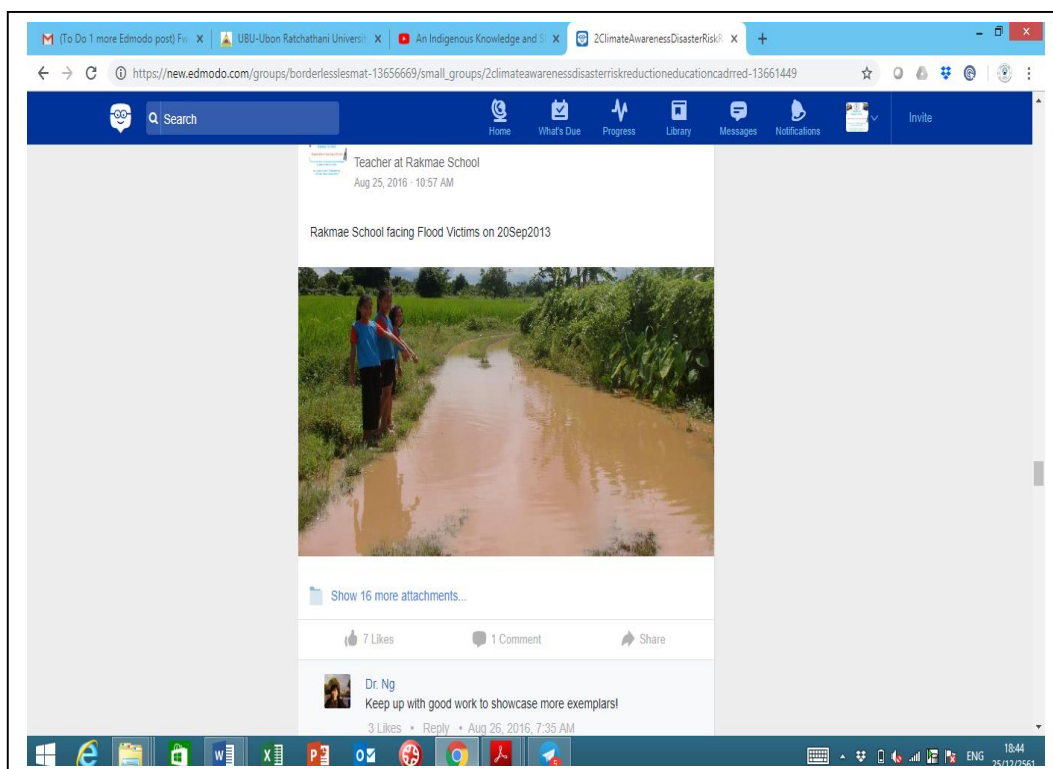


Figure 4. Printscreen of students’ participation in Environmental Education integrating ICT project with output posted on ‘LearnT-SMArET’ sub-theme and write-up published in Media 8 writing platform. [\[http://bit.ly/cadreddconwurarticle\]](http://bit.ly/cadreddconwurarticle)

Conclusion

This article illustrates technology-enhanced science PBA integrating indigenous knowledge and skills including illustration of exemplars as well as discussions of issues and challenges.

Summary and Significance/Implication of Findings

Based on the findings of the study, the following conclusions are drawn:

- It can be inferred that the school practices on PBA in five schools such as agriculture, handicraft, investment, and skill development, self -development were acceptable to project based standards.
- The practices were found in consonance to the techniques adopted to develop projects.
- In the spirit of collaboration, schools are able to make adjustment to the needs of time and living up the Thai expectation that Thai practice the Kings' philosophy.
- In the traditional assumptions of the students, the problem of the project-based learning is the traditional assumptions of the students. Most of the students have spent their previous years of education assuming their teacher as the main disseminator of knowledge. Because of this understanding towards the subject matter students lack the ability to simply wonder about something in the initial years of PBA.
- In the information overload, since it is self-directed study the students are sure of how much self-directed study to do and what information is relevant and important unless they are properly guided by the instructors.
- In Pupil's evaluation, the instructors have to adapt new assessment methods to evaluate the pupils' achievement. They have to incorporate written examinations with modified essay questions, practical tasks, peer and self-assessments.

Thus, this study will be of special benefits to the following sectors as concurred with the literature review.

The schools. The adoption of PBA management based on all the innovations anchored on the philosophy of sufficiency economy introduced and implemented is in order to complement all the progressive changes in Thailand. This research is a timely initiative as a methodology for increasing academic performance.

Teachers. This study will give the teacher the edge to ensure that students are kept in the school and learning. For teachers, additional benefits include enhanced professionalism and collaboration among colleagues, as well as opportunities to build relationships with students (Thomas, 2000). Additionally, many teachers are pleased to find a model that accommodates diverse learners by introducing a wider range of learning opportunities into the classroom. Teachers find that students who benefit the most from PBA tend to be those for whom traditional instructional methods and approaches are not effective.

Students. Opportunities were given to students to use the materials in this study that are interesting, engaging and challenging in ensuring that Thai youth learn the legacy of the late revered King of Thailand, in which sufficiency economy was instilled in their minds and in their heart in all the things they do in and out of the school as well as their life after school.

For many students, the appeal of this learning style comes from the authenticity of the experience. Students take on the role and behaviour of those working in a particular discipline. Whether they are making a documentary video about an environmental concern, designing a travel brochure to highlight sites of historical significance in their community, or developing a multimedia presentation about the pros and cons of building a shopping mall, students are engaged in real-world activities that have significance beyond the classroom.

Limitation and Suggestions for Future Studies

The study gathered data through interview, focus group discussions but did not however attempt to establish the impact of implementing PBA on the students and other education stakeholders. The following are some constraints faced in this study:

- In the adoption of PBA, there are constraints encountered that were addressed through collaboration among school administrators, teachers and the students themselves.
- Lack of support from school authorities. The school director (principal) does not allocate enough funds for project materials and staff development.
- Not enough time to facilitate the full PBA.

Upon reflection, the researchers also felt that more education to instil moral values should also be incorporated inside programmes and activities to empower values-based lifelong skills development. Studies to adapt more topics on ‘Education for Sustainable Development’ (ESD)-related issues in achieving Sustainable Development Goals (SDGs) (United Nations, 2015), cross-cultural values education and entrepreneurship should also be included.

Further skills training activities involving online courses will be organized in collaboration with regional training centre to promote technology, thinking (critical/creative, logical thinking and reasoning skills) and life (work/entrepreneurial/survival) skills using the curricula developed for PBA.

The administration of on-line survey entitled ‘Attitudes Towards Use of Digital-tools and Application of Philosophy of Sufficient Economy’ (ATUDAPOSE) through Google form will be prepared to explore the respondents’ attitudes towards use of technology and application of philosophy of sufficient economy for sustainable living. More efforts will also be made to leverage on the Edmodo social learning platform and digital tools towards Education for All (EFA). R&D activities should also be conducted incorporating blended learning platforms with more sharing of exemplary practices among the stakeholders in the SEAMEO region and beyond.

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