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Education for Inclusive Growth on 4th Industrial Revolution for Society 5.0

Southeast Asian Ministers of Education Organization

University of Tsukuba
筑波大学

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The *Journal of Southeast Asian Education* is an official Southeast Asian Ministers of Education Organization (SEAMEO) publication and aimed to publish twice a year.

The main purpose of this international journal is to provide information and analyses to assist in policy-making and planning in the countries in the region. It promotes the interchange of ideas on educational issues and comparative studies, both within the countries of the region and other parts of the world. Each article in the journal was written to enable readers from outside each country to obtain an overview of how education is carried out outside its borders.

The theme of this issue is "Education for Inclusive Growth on 4th Industrial Revolution for Society 5.0." It is a product of SEAMEO's collaboration with the University of Tsukuba. It features official contributions from nine SEAMEO Regional Centres, namely, SEAMEO INNOTECH, SEAMEO RECFON, SEAMEO Regional Centre for Quality Improvement of Teachers and Education Personnel (QITEP) in Mathematics, SEAMEO QITEP in Science, SEAMEO BIOTROP, SEAMEO CED, SEAMEO SEN and SEAMEO CECCEP. Other contributors came from various universities such as the University of Tsukuba (Japan), Khon Kaen University (Thailand), University of the Philippines National Institute for Science and Mathematics Education Development (UP NISMED), the Korea National University of Education, and also Ministry of Education, Culture, Sports, Science, and Technology (MEXT), Japan. The various articles in this journal present frameworks, projects and programmes focusing on reform and initiative in teacher education for the digital society in Southeast Asia and beyond.

The inaugural issue of the *Journal of Southeast Asian Education* was launched by the SEAMEO Secretariat in July 2000.

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Foreword

Digital technologies have permeated our everyday tasks and interactions in the 21st century. In turn, the digital innovations are reshaping our society, economy, culture, and lifestyle. They have changed the way we learn, work, and socialise. Their ability to impact all aspects of our society cannot be overstated. Consequently, we have to reform our education system so that the learners will be ready to embrace a new world they encountered. The papers on education for inclusive growth on 4th Industrial Revolution for Society 5.0 in Southeast Asia and beyond featured in this journal highlight some of the highly effective collaboration initiatives undertaken by researchers from various universities such as the University of Tsukuba, University of the Philippines, Korea National University of Education, and Khon Kaen University of Thailand and exemplary programmes from nine of the regional centres of SEAMEO to improve lives across the region.

This journal, supported by the University of Tsukuba, presents good practices and examples of pioneering programmes that seek to provide recommendations and solutions to issues and challenges that address national, regional, and global educational concerns.

SEAMEO's motto, "Leading through Learning," reflects the organisation's leadership and commitment to promote quality education, science, and culture in Southeast Asia and beyond. Through the activities and strategies undertaken by its 26 regional centres/network, SEAMEO is able to reach out to diverse communities in Southeast Asia to contribute to the development of human resources (HR) and address challenging issues such as alleviating poverty, creating a better quality of life, providing educational equity and quality, enhancing agriculture and natural resources as well as health and nutrition, and promoting the dissemination and exchange of knowledge and learning of indigenous cultures and traditions.

We hope this journal serves as a source of learning and reference for educational institutions across Southeast Asia. We are also confident that it will help the general public better understand the nature of the work of SEAMEO, which will continually expand and grow as the organisation strides into a new stage of growth in the 21st century, described in our 10-year strategic vision as "The Golden SEAMEO."

The SEAMEO Secretariat would like to thank the ministers of education, senior officials of SEAMEO Member Countries, and centre directors for their commitment and unfailing support over the years.

We also wish to recognise the excellent cooperation we have received from the University of Tsukuba, SEAMEO regional centres, and other partner organisations. All of these efforts have, in one way or another, contributed to the completion of this journal.

Dr. Ethel Agnes P. Valenzuela
SEAMEO Secretariat Director

Editorial

In 2017, the World Economic Forum (WEF) and the Asian Development Bank (ADB) jointly produced a white paper that focused on the impact of the Fourth Industrial Revolution (4IR) on the Association of Southeast Asian Nations (ASEAN).

The Fourth Industrial Revolution refers to a set of highly disruptive technologies, such as artificial intelligence (AI), robotics, blockchain and 3D printing, that are transforming social, economic and political systems and putting huge pressure on leaders and policy-makers to respond. (WEF & ADB, 2017, p.4)

This white paper set out some of the challenges and issues as a result of the Fourth Industrial Revolution and provided a number of suggestions for the ASEAN body and the individual member countries to consider. Then the world pandemic COVID-19 added to these challenges and created a New Normal for educators throughout the region. In response, SEAMEO member countries have developed a range of policies and programmes that cater to their specific individual issues and contexts. As well, the SEAMEO organisation has instituted a number of strategies to provide avenues for the sharing of expertise and initiatives among these member countries. For example, the two Strategic Dialogues of Education Ministers (SDEM) organised by SEAMEO produced the SEAMEO 7 Priorities (First Strategic Dialogue) and the setting of the Bandung action agenda (Second Strategic Dialogue). These are but two of the many directions that SEAMEO has produced as it continually encourages, expands, and challenges the various bodies that make up the SEAMEO organisation to increase the dissemination and sharing of expertise and initiatives among the member countries. This journal is one of the responses to the SEAMEO challenge.

This issue has a collection of papers from around the region which highlights initiatives and programmes such as:

A new model proposed by SEAMEO INNOTECH for generating and sharing knowledge within the region. This regional knowledge sharing platform would cater to a variety of education actors such as teachers, education managers, and policy makers. It has already formed a network of contributors.

The Sustainable Development Goal 2 Target 2 and SEAMEO Priority Areas 1 and 2, were the motivation for SEAMEO RECFON's response via their *Early Childhood Care, Nutrition and Education* and Nutrition Goes to School programmes. These programmes aim to help secure a health and nutrition-conscious young Indonesia generation in order to support the creation of a Society 5.0.

Sustainable Development Goals and climate change were the motivation for the SEAMEO Regional Centre for QITEP in Science to conduct an extensive literature review on STEM as a resource for future planning. STEM learning was proposed to assist in developing students' climate literacy and ways to overcome climate change issues.

The SEAMEO Regional Centre for QITEP in Mathematics shared a research study involving critical thinking in a primary mathematics lesson using the calculator as a problem-solving tool. The results contribute to the available literature on the positive ways to use calculators in primary school mathematics and to help rectify negative perceptions.

The SEAMEO BIOTROP's responded to the challenge of revitalising secondary vocational high school in agriculture through three main programmes that provided a valuable resource to other institutions and bodies. The programmes focussed on fruit tree gardening, food security, and the establishment of a teaching factory. The programmes have the potential to develop a transfer technology hub in agriculture for the surrounding communities and farmers.

Responding to the challenges of Sustainable Development Goal 4 and their Special Education Need students, SEAMEO SEN explored the key elements of the technical and vocational education and training programme for their SEN students with the aim of establishing connections to employment opportunities.

Responding to the issue and challenges of STEM, SEAMEO RECSAM developed a STEM Planning and Design Learning framework to assist educators in their lesson planning and classroom implementation. An important stage was the development of human empathy in the student learning process.

Motivated by equity challenges in SEAMEO's Seven Priorities and the UN's Sustainable Development Goals, SEAMEO CECCEP promotes inclusive early childhood education and parenting through a research hub that collects and analyses data and disseminates information and expertise, thus increasing parents, teachers, and governments' understanding and commitment to gender equality and equity.

Promoting diversity, especially among Lao Village Education Development Committees, was a challenge for SEAMEO CED. Their efforts through a number of community-based activities made a contribution to the field of knowledge and involving the improvement of the teaching and learning environment and the linking of home and school cultures.

Japan has been an active long-term partner of SEAMEO and has made significant investment in establishing relationships with member countries. This paper presents the history of the Japanese government's cooperation with SEAMEO. Some of the existing awards are introduced and a discussion of Japan's plans for further cooperation with SEAMEO are presented.

Japan's universities are also part of the relationship with SEAMEO. The University of Tsukuba's main mission is the creation of knowledge and this paper contributes to the pool of knowledge involving inclusive education and globalisation. It describes several globalisation and inclusive education activities that have been implemented in the university.

Another part of the University of Tsukuba's creation and dissemination of knowledge involves its laboratory school. It holds international symposiums involving other universities and their laboratory schools in Indonesia, Thailand, and the Philippines, and it has established an international network through JICA's overseas teacher dispatch programme.

This paper describes this and other initiatives designed to build a sustainable society for future world peace.

The University of the Philippines National Institute for Science and Mathematics Education Development was challenged by the importance of digital competence as a vital 21st-century skill for teachers and students This paper examines the implications of specific digital competencies that bear upon the standards of teacher professionalism in the Philippines.

The Korean National University of Education's mission of creating and disseminating knowledge involves the enormous challenges posed by Artificial Intelligence (AI). This paper discusses AI education and AI-related coding education and presents three AI-related teacher training programmes the Korea National University of Education has provided.

Khon Kaen University's Centre for Research in Mathematics Education, Institute for Research and Development of the Teaching Profession for ASEAN collaborated with the University of Tsukuba in promoting Lesson Study. This paper presents a history of the APEC Lesson Study Project (2005-2018) proposed by Thailand and Japan from Thailand's perspective. The paper also highlights further collaboration between the two partners.

It is hoped that this collection of papers will disseminate some of the highly creative and inspiring responses to the challenges of Education for Inclusive Growth in the 4th Industrial Revolution for the Society 5.0. It is worth reminding readers that the best predictor of future life, health, wealth, and happiness depends not so much upon school achievement as much as the number of years spent in schooling (Levin, Belfield, Muenning, & Rouse, 2006). The student population is very diverse and the challenge is to cater for this diversity in ways that encourage students to stay in learning, to improve their sense of being, their self-respect, their respect for others and to empower them to achieve their potential.

Dr Wahyudi
(SEAMEO Secretariat)

Dr Allan L. White
(SEAMEO Fellow)

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Regional Partnership for Capacity Building on Global Citizenship and 21st Century Skills: Towards a Regional Knowledge Sharing Platform

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Abstract

The paper draws from the recommendations made during two Strategic Dialogues of Education Ministers (SDEM) organised by SEAMEO within the framework of the ADB SEAMEO College Initiative. The establishment of the SEAMEO 7 Priorities (First Strategic Dialogue) and the setting of the Bandung action agenda (Second Strategic Dialogue) prompted a programmatic response from SEAMEO INNOTECH. The programmatic response focused on developing a new model for generating and sharing knowledge within the region. The paper outlines the concept and the research undertaken to develop a mechanism for undertaking a knowledge audit and the mechanisms for sharing and exchanging knowledge and information among institutions in the region. INNOTECH, a SEAMEO regional centre devoted to educational innovation and technology, has consistently nurtured partnerships with various institutions in order to facilitate knowledge sharing as well as capacity building services. The regional knowledge sharing platform caters to a variety of education actors. Global citizenship education and the development of 21st century skills can be enhanced and facilitated among teachers, education managers, and even policy makers. Some specific interventions are outlined and presented as possible starting points for discussion.

Keywords: Knowledge audit, knowledge management, knowledge networks, partnerships

Introduction

Over the five decades of sustained operations in Southeast Asia, the SEAMEO Regional Centre for Educational Innovation and Technology (SEAMEO INNOTECH) has pursued its mission of "identifying and helping solve common and unique problems, as well as anticipate educational development needs in the Region," as enshrined in its Enabling Instrument. The Centre serves the educational development needs through three service areas: research and development of innovative solutions to education development concerns, enhancing the human infrastructure in education and disseminating new knowledge and information on educational innovations.

The education landscape in Southeast Asia has significantly changed over the past decades since the Centre's establishment. INNOTECH was born amidst a region with newly independent nation states that had to confront a number of development and social issues and for the education system to meet the demands of society. Southeast Asia is now among the most economically dynamic regions of the world, with some of the countries among the best performers in international assessments.

After 50 years, however, the compelling reasons remain for a regional centre dedicated to educational innovations and the application of technology for teaching, learning, and governance of education. Beyond addressing issues in access, the journey for quality is a continuing enterprise, pursuing an ever-moving goal. The shifting demands on educational systems in the region to keep pace with the rapidly transforming societies prompts the development and adoption of solutions on a regional scale.

Yet the compelling reason remains for regional cooperation in order to address education development needs. In keeping with its mandate of identifying common education development issues in the region and unique educational needs in each SEAMEO Member Country, the Centre was tasked to organise the first and second Strategic Dialogues for Education Ministers (SDEM) in 2014 and 2016, respectively. These Strategic Dialogues were convened in collaboration with the SEAMEO Secretariat and with the host Ministries of Education, the Lao PDR Ministry of Education and Sports for the first SDEM, and the Ministry of Education and Culture of Indonesia for the second SDEM.

The SEAMEO Seven Priorities and the Bandung Platform for Action

The two SDEMs were convened and brought together the education leaders in the region to collectively reflect on the needs and future collaborative actions within the framework of the SEAMEO College Initiative, a series of activities organised by SEAMEO with the support of the Asian Development Bank through the Japan Solidarity Fund.

SDEM 1 yielded the seven priority areas for SEAMEO programmatic action. Building on the strengths and experiences of the countries in the region, the SEAMEO Seven Priorities helped form the region's agenda to support the global Sustainable Development Goals, particularly SDG Goal 4, focusing on education. The Forum noted the progress made by the SEAMEO countries in the area of education, training, and human resource development as well as in teaching, learning and the governance of schools and education systems. The region and individual countries have implemented good and exemplary practices towards achieving their educational goals and objectives, serving as enablers that contributed to the economic dynamism of the region.

Aside from identifying priority action areas, the Ministers also called for cooperation among the countries in the region as an essential and potent resource. The transformation required in the region would be strategic, comprehensive, and systematic, while rooted in the values and traditions of the region. The Ministers further called for focused collaboration and interactions in the next two decades in the identified priority areas to address the issues and challenges.

SDEM 2, convened in Bandung, laid down the framework for cooperation in order to make the SEAMEO Seven Priorities operational. Among others, it called on SEAMEO Members to collaborate, in bilateral, multiple countries or regional initiatives, by sharing expertise, knowledge and experiences to address a specific education development concern. It further called on the regional centres of SEAMEO to facilitate these bilateral and multilateral initiatives.

The Region has much to share in ensuring access and relevance of the programmes to the needs of the learners; given the diversity of needs, resources and operational contexts, the shared concerns on early childhood education, technical and vocational education and training, lifelong learning and keeping the child at the centre of learning interventions. In the process of introducing innovations to the curriculum and learning content, strong fundamental skills such as literacy, numeracy, values as well as social and emotional skills should be enhanced. Public engagement is deemed important to the success of the programmes and reforms. Different modes and types of public engagement present in the Region were explored, such as strengthening the school community partnership, promoting open and shared information, and other modalities. In engaging the education workers, particularly teachers, it recognised that not only instilling a sense of professionalism and technical competence was called for, but also in developing the capacity to nurture, understand and inspire future citizens in individual countries.

Taking the Ministers' call to action, SEAMEO INNOTECH has redoubled efforts at engaging the various sectors of the region's education community. The Centre's knowledge management framework builds on the call for collaboration and drawing together the region's knowledge resources in order to effectively and efficiently respond to the educational needs of the different countries. Further effort was focused on relationship building among national organisations, academic institutions and professional organisations representing the education workforce. These initiatives were pursued to complement regional initiatives managed by the SEAMEO Secretariat.

The INNOTECH Knowledge Management Framework

The mandate of SEAMEO INNOTECH is primarily dedicated to identifying common and unique education problems and needs of Southeast Asian countries, and developing innovative and technology-based solutions to address these needs and problems. Over the years, the Centre, through its different operational units, has generated several knowledge products and solutions. These are shared on different platforms operational to both internal and external stakeholders.

Knowledge flow within the Centre is dynamic. The development of the Centre's knowledge products and services is an output of synergy among the different offices such as the Learning Management Office (LMO), the Educational Research and Innovation Office (ERIO), the Knowledge Management and Networking Office (KMNO), the Quality and Systems Management Office (QSMO), the Administrative Management Office (AMO) and the Finance Management Office (FMO); both offices were merged as of July 2020 to form Finance and Administrative Management Office (FAMO). Each office contributes to the Centre's knowledge generation and sharing processes.

As the Centre expands its reach and deepens its experience and engagement on educational development and innovations in Southeast Asia, it continuously evolves as an organisation. The changes in the Centre also influences the knowledge flowing in and out of it, including the development of its knowledge products and resources. In order to keep track of the different knowledge products and resources of the Centre, a knowledge inventory survey was conducted in 2011. This initiative was the Centre's initial attempt to map out its existing knowledge products and resources.

Knowledge Management was defined by Edvardsson and Oskarsson (2013, p.3) as: "developing, sharing and applying knowledge within the organisation to gain and sustain a competitive advantage". Knowledge is becoming an important asset of organisations with the emergence of the knowledge economy, hence the importance of managing knowledge effectively.

Omotayo (2015), noted that managing knowledge has generated considerable interest in business and management circles due to its influence in the delivery of organisational strategic results in relation to its bottom line. The management of knowledge is promoted as an important and necessary factor for organisational survival and maintenance of a competitive edge. Knowledge and management of knowledge are important for organisational survival and growth.

Knowledge Management (KM) became a key strategic focus for INNOTECH in 2006. The aim of KM was to enhance the organisation, integration, sharing, dissemination, and delivery of knowledge across all levels of the organisation, including its stakeholders. The principal body for KM is the Knowledge Management and Networking Office (KMNO) which serves as the principal external relations and extension service of the Centre. It also facilitates the movement of knowledge products and services from the organisation to its intended users, bringing together the various areas of focus and solutions developed by the Centre.

The Centre's framework views KM as two distinct and interconnected paths: (1) Inward Knowledge Management or Organisational KM where knowledge is being managed to ensure efficient and prompt delivery of operational processes within the organisation; and (2) Outward Knowledge Management or Knowledge Management for Educational Development or KM4ED, where the Centre's knowledge outputs are managed for effective use, application, adoption and adaptation by external stakeholders.

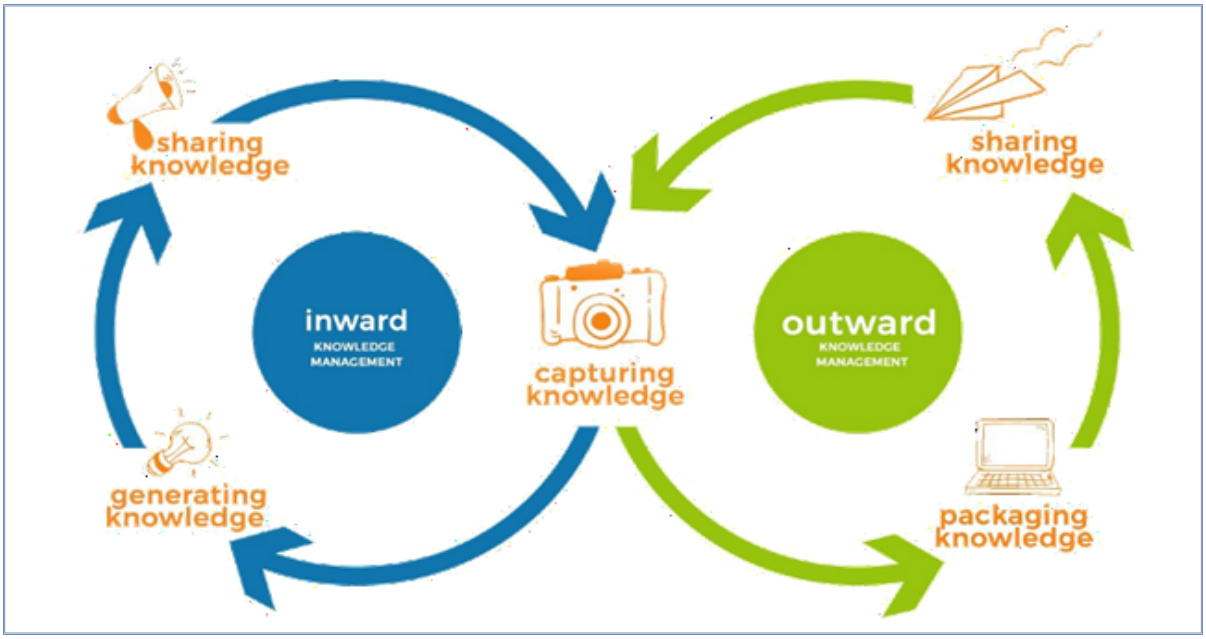

Figure 1. *Knowledge Management Framework of SEAMEO INNOTECH*

The Centre's KM model departs from the traditional model whereby we are confined mainly to generating new knowledge and promoting/disseminating these solutions. Complementing the knowledge creation function would be the capability to acquire, organise, co-develop and package knowledge and information shared by various partners, for application in the different countries.

Part of the strategy of building a network of partners within and outside the region is the potential to make fuller use and apply the knowledge assets to address education concerns among the partners in the region. From a practical, business development standpoint, a network of educational institutions in the region, with access to knowledge assets even outside the region is better positioned to serve the needs of a SEAMEO Member Country. Needs are better articulated and understood in the operational context of the country, while a broad range of knowledge assets can be utilised to come up with appropriate knowledge products and services that address the country's needs.

Sharing and exchanging knowledge also hews closely to the "Southeast Asian way," for each country to gain the benefits from the shared knowledge pool.

Knowledge Audit

The assessment of identified existing processes and practices will help an institution gauge where its strengths and weaknesses lie vis-à-vis efficient and effective service and product delivery. A knowledge audit (KA) investigates the organisation's knowledge assets or resources, where are they lodged, who interacts with them, and how they are accessed. The following components are examined during an organisational knowledge audit:

- knowledge needs
- knowledge assets or resources
- knowledge gaps
- knowledge flow; and
- knowledge blockages

A knowledge map is developed as a result of the knowledge audit. The pilot KA conducted at the Centre aimed to capture selected KM practices in order to identify knowledge gaps and to recommend enhancements of the said KM processes. The pilot KA also aimed to document the KA process and develop guidelines to be adopted by the different offices.

The pilot audits that were conducted took on two different tracks. The KA track on Business Development Process followed four steps, 1) preparatory phase, 2) brainstorming workshop, 3) validation workshop, and 4) analysis and report writing. On the other hand, the KA track of Research and Knowledge Products Dissemination Process is as follows: 1) preparatory phase, 2) familiarity survey and data gathering, and 3) analysis and report writing.

The audit of the Business Development Process documented existing business practices at KMNO. These practices were the building blocks in developing the business development framework. The business development framework documented was validated through centre-wide consultations and a workshop.

The Knowledge Audit of the research and knowledge products dissemination process checked how process owners understood and used the said process. The dissemination process, compared with that of the business development process, has an existing written document available to everyone. The KA on dissemination process has a set of targeted audiences who were the primary respondents of the survey.

The KA pilot was able to elicit the business development needs of KMNO and the Centre. For marketing to be an effective strategy in expanding and deepening client outreach. The Centre has an established dissemination process, and for the process to effectively work, regular orientation or refresher will help reinforce staff understanding and familiarity with the process.

In the context of the regional knowledge network, this is a viable first step towards gaining a better understanding of the knowledge assets that can be shared with partners.

Five Steps in Conducting a Knowledge Audit

KMNO adopted the following knowledge audit in five (5) main activities: the preparatory phase, audit briefing, data gathering, audit data analysis, and action planning.

Figure 2. *The Knowledge Audit Process*

The preparatory step is done to discuss and decide on the objectives and scope of the planned KM audit. The objectives will be the basis for developing its KA questionnaire or tool. This will be done by doing an extensive desk review of documents and existing process maps at the Centre. The KA tool or instruments to be developed in this step should comprise of the following core questions on the process/es to be audited:

- What is the process?
- How is the process done?
- Who is involved in the process?
- What does the process try to achieve?
- What is my role in the process?
- How is the process related to the overall goal of the Centre?

Towards a Regional Knowledge Platform

In keeping with the Centre's KM framework, significant efforts have been made to develop a network of institutions throughout the region that would serve as the Centre's partners and co-developers of solutions to address specific education development needs. Over the past decades, national education institutions, teacher education and training colleges, the academe, non-government organisations and other stakeholder groups have developed a significant body of knowledge in the area of educational innovations. Individual teachers and school managers have their own success stories that may be shared with others in the region.

The traditional business model whereby a specialised body generates new knowledge and solutions and diffuses (or disseminates) research and development outputs could be levelled up by sharing and exchanging documented knowledge and information and setting them to practical use by other organisations in the region. Customizing solutions and setting them in the context of the users would be further enhanced by institutions working in tandem to address a specific issue.

An emerging business model, where partners focus on a problem, work together to search for solutions and collaboratively try out and validate them, would mark a more meaningful engagement among parties.

Every organised entity has its own knowledge assets. A regional platform would enable working towards connecting the forms of knowledge that institutions already possess and the new forms of development, acquisition and spread of knowledge valued by the participating countries. The evolution of social networks made possible through the Internet also yielded enhanced opportunities for sharing and synergy among organisations with shared goals and purposes. It also made building and growing networks of institutions, individuals, and groups throughout the region possible, moving us closer to being a concert of caring and sharing societies.

Drawing from experiences in social media and networks, current technology would also enable customization of materials and learning experiences. Younger teachers may seek guidance and advice from more experienced educators, and the collective insights drawn could guide the future development of professional support programs.

By building platforms for sharing and exchange of knowledge and information, the codified knowledge assets generated by INNOTECH could be enhanced and enriched by the experiences and expertise shared by others. Networks among institutions could also bridge language gaps, enabling a better fit between research-based solutions to the on-ground realities and operational contexts of the different countries.

A Platform for Concerted Action

In keeping with the recommendations of the Bandung Strategic Dialogue, the regional knowledge network could serve as a platform for identifying the development needs of individual member countries and for putting together possible solutions from a variety of sources to address these needs.

At present, INNOTECH has formal linkages with several institutions across the region that provide knowledge services to the education sector. A list of some of the partners outside the Philippines, as well as some partner universities, is presented in Annex 1. The Centre hopes to grow the network of partners to be able to cover a wider and deeper reach within the region. Such partnerships dovetail with the inter-centre collaboration activities coordinated by the SEAMEO Secretariat, which allows each centre to complement existing expertise and programs in the other centres located in other countries.

At present, several online platforms exist for direct education service provision. A platform for sharing and exchanging knowledge in the area of educational innovation could be a viable feature in the region's education ecosystem. Some of the practical applications and services that a platform may provide are:

- Knowledge/Information Sharing and Exchange. Knowledge exchange and sharing may be considered as the simplest and most common activity for the participating organisations. This may be done at the individual level (interactions among teachers, fellow principals, and similar education workers). Codified knowledge and research outputs may be collected, synthesized and shared with other users.

- Professional Development for Education Workers. Learning opportunities for different classes of education professionals and workers in allied fields could be enhanced with a deeper understanding of the learning needs and the capability building services that could be provided. Training interventions may be co-developed, taking advantage of the expertise, materials and training approaches that fit the requirements. The regional knowledge platform can provide the mechanism for various organisations to pool knowledge and resources to be able to provide the appropriate training experience.

- Technical Assistance. The regional knowledge platform could serve as a means for putting together the appropriate technical experts to work on education development issues within the region. Such technical assistance can promote capability enhancement in the projects and programmes that would use their expertise as well as the institutions that make a contribution.

- Environmental Scanning and Business Development Information. Some of the countries in the region are eligible for official development assistance and development support. The knowledge sharing platform can serve as a means for others to be informed of business opportunities, leveraging on their expertise and experience.

On the part of SEAMEO INNOTECH, regional initiatives are being pursued to be undertaken through the knowledge-sharing platform. Some of these undertakings are:

- Translation of Knowledge Materials. The Centre's knowledge products can reach more users when translated into the appropriate national language. These translation projects are being undertaken with sister SEAMEO centres and partners. Given more partners, more translation and co-publishing projects can be done not only with research reports and monographs but also learning modules, reference materials and other knowledge products.

- Review and Updating of Knowledge Products. Some of the learning resources for online programmes require updating, given the wealth of materials being developed. Collective work on updating the contents and a consensus recommendation on appropriate design would be among the first undertakings within the platform framework.

- Co-Design and Implementation of Learning Events. Among partner institutions, collaboration in conducting training programmes, both face to face and online would be expected to evolve into joint programmes and co-badging arrangements.

- Development of New Knowledge Products. Leveraging on the knowledge of national institutions on the specific needs of the education workers in the country, the platform is envisaged to collaboratively design and develop new knowledge products that directly address the knowledge and information needs of the stakeholders.

The knowledge sharing platform is envisaged to play a significant role in some on-going initiatives being pursued by the Centre:

- ASEAN eXCELS. The initial course aimed at building the capacity of school heads in Southeast Asia in understanding the emerging ASEAN Community, for the school principal to serve as the champion of ASEAN integration in the school community. The project proposes to train school Heads from the ASEAN Member States using the SEAMEO INNOTECH-developed international blended learning course entitled: ASEANeXCELS (Excellence in School Leadership for Southeast Asia: Promoting an Understanding of the ASEAN Community).

  As a regional undertaking, the project proposes to capacitate a core group of online facilitators to support the online training of school principals throughout the region. The two-module course comes with a toolkit, Weaving Identities which is a resource package to support teachers in presenting learning content on ASEAN and the diverse cultures, history, and economic systems in the region. The proposed project is being designed as a collaborative undertaking of education institutions and universities in the region and beyond.

- Peace eXCELS and GCED. The online program seeks to develop the capability of school principals in promoting peace and respect for diversity in the school community. As a regional initiative, championing peace may be complemented with enhanced knowledge on Global Citizenship Education and integrating GCED in the learning program. The project proposes to enhance the current content of Peace eXCELS and incorporate elements of GCED in the modules. The activity will build on an informal network of GCED practitioners set up in 2015 and currently interacting through WhatsApp, allowing diverse viewpoints on GCED application as practiced in some countries in Africa, the Middle East and Asia Pacific.

The foregoing projects focus on developing a better understanding of the Southeast Asian Community and the need to develop global citizenship. The learning resources to be developed build on the capacity development of school heads and lead teachers to provide support for teachers in the classroom. These programs support the SEAMEO Priority on adopting a 21st Century Curriculum, addressing the needed knowledge and skills to effectively respond to the changing global context and promoting ASEAN integration in the learning community, with teachers imbued with ASEAN ideals.

The Road Ahead

The first 50 years for SEAMEO INNOTECH focused on the development of solutions for improving teaching, learning and management of education in the region when it has pioneered innovative learning systems and promoting access to quality learning in the context of resource limitations. The next decade offers an opportunity to leverage the region's knowledge assets and meaningful engagement with various education actors and stakeholders.

The current environment provides a window for speeded up responses to education challenges, closer and meaningful engagement, and even greater relevance for the Centre's services and products to the region's education community. Meaningful involvement of the key stakeholders in developing and making improvements to their practices are but some of the dividends in riding the waves in building a regional knowledge platform.

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Annex 1. SEAMEO INNOTECH Partners in Southeast Asia

- National Institute of Education, Cambodia
- MOEYS Education Research Council, Cambodia
- Institute for Education Administration Development, Lao PDR
- NIE International Pte Ltd. (NIEI)
- Institut Aminuddin Baki, Malaysia
- National Institute for the Development of Teachers and Other Education Personnel
- Teachers Council, Thailand (KHURUSAPPHA)
- Institute for the Promotion of Teaching Science and Technology, Thailand
- National Institute for Training of Teachers and Education Professionals, Timor Leste
- Viet Nam Institute of Educational Sciences
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Securing a Health- and Nutrition-Conscious Young Generation through the School and Community Education System for Society 5.0

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Abstract

The creation of a Society 5.0 would require quality human resources that are forward-looking, smart, responsible and practice an active and healthy lifestyle. Balanced nutrition contributes to producing this kind of human resources that are critical in bringing about faster economic growth and reducing social problems for society members. SEAMEO RECFON promotes balanced nutrition from early childhood to adolescent-aged school children through its two flagship programmes, namely: Early Childhood Care, Nutrition and Education (ECCNE) and Nutrition Goes to School (NGTS). The NGTS Programme is a school-based multisectoral - programme launched in 2016 to build the character and improve students' learning outcomes and active participation in school activities by practicing proper nutrition, hygiene and sanitation. It is being piloted in six districts in East and West Java, and West Kalimantan provinces in Indonesia involving 55 primary, junior high and vocational schools. The ECCNE Programme was conceptualised in 2017 as a community-based multisectoral intervention programme aimed at providing a model of integrated implementation of essential components of childcare and parenting to ensure optimal psychomotor, cognitive and affective growth and development of a child. It is being piloted in one district each in East Java, West Kalimantan and Central Sumatra provinces in Indonesia involving 54 community early childhood education centres. These programmes are SEAMEO RECFON's attempts to contribute to Sustainable Development Goal 2 Target 2 and SEAMEO Priority Areas 1 and 2. This paper presents the experiences and contributions of SEAMEO RECFON's ECCNE and NGTS programmes thus far in Indonesia to help secure a health- and nutrition-conscious young generation to support the creation of a Society 5.0.

Keywords: Adolescent nutrition, early childhood nutrition, school-based nutrition promotion, Society 5.0

Introduction

Malnutrition is a global and multisectoral concern that affects human capacities to contribute to national development. The so-called triple burden of malnutrition, (i.e. underweight, overweight, and nutrient deficiencies) does not discriminate for age, socioeconomic class and gender and could result in different types of illness and mortality.

These forms of malnutrition can co-exist in the same individuals, within households and communities across different countries and regions. Thus in 2015, the UN member states agreed to "end malnutrition in all its forms" as Target 2 under the Sustainable Development Goal (SDG) 2 by 2030. SDG 2 focuses on ending hunger, achieving food security, improving nutrition, and promoting sustainable agriculture. The UN also declared 2016-2025 as the Decade of Action on Nutrition to accelerate the implementation of this target globally towards a healthy and productive population.

Under-five and school-aged children up to adolescence are considered among the sectors of the society that are most vulnerable to malnutrition. Malnourished children are most likely to experience slow or poor brain development which then affects their performance in school. In the long run, this may limit their opportunities to find a decent job during adulthood and thus affect the country's economic growth.

Southeast Asian countries experience varying forms of malnutrition. The 2018 Global Nutrition Report indicates that overweightness is prevalent in Brunei Darussalam, anemia in Singapore, stunting in the Philippines, overweightness and anemia in Thailand, stunting and anemia in Cambodia, Indonesia, Lao, Myanmar, Timor-Leste and Vietnam, and overweightness, anemia and stunting in Malaysia.

In support of the SDGs, the Southeast Asian Ministers of Education Organization (SEAMEO) identified seven priority areas in 2015 wherein the mandates and expertise of its 26 specialist centres could be fully tapped. The seven priorities are (1) Achieving Universal Early Childhood Care and Education, (2) Addressing Barriers to Inclusion, (3) Promoting Resilience in the Face of Emergencies, (4) Promoting Technical and Vocational Education and Training, (5) Revitalising Teacher Education, (6) Promoting Harmonisation in Higher Education and Research, and (7) Adopting a 21st Century Curriculum.

As one of the specialist centres of SEAMEO, the Regional Centre for Food and Nutrition (RECFON) initiated two flagship programmes under its Second Five-Year Development Plan (FY 2016/2017-2020/2021) to address the first and the second priority areas, namely: Early Childhood Care, Nutrition and Education (ECCNE) and Nutrition Goes To School (NGTS), respectively. These programmes are also the Centre's modest attempts to contribute to achieving SDG Target 2.2. SEAMEO RECFON believes that promoting proper nutrition among the young generation could help them secure a better future and allow them to respond to the demands of the Industrial Revolution 4.0 and conform to the vision of Society 5.0.

The ECCNE and NGTS programmes subscribe to the life-cycle approach to nutrition development of individuals from early childhood to adolescence. The Centre sees the critical role of the school and community education systems in achieving this goal.

General Approach, Framework, Intervention Type and Coverage of SEAMEO RECFON's ECCNE and NGTS Flagship Programmes

Approach

SEAMEO RECFON adopts mitigation and prevention approaches for its flagship programmes in combatting malnutrition among the under-five and school-aged children. The ECCNE Programme focuses on a mitigation approach towards preventing the effects of malnutrition among under-five children during the later stage of their life. On the other hand, the NGTS Programme deals with a prevention approach to avoid newborns from becoming malnourished by providing nutrition education to adolescent school children who would eventually become parents.

Framework

Both programmes operate within the Demand, Supply, Policy, and Information System (DSPIS) framework (Fig.1). The programmes are expected to respond to and/or create the demand for target stakeholders to choose healthier and nutritious foods that could be made available within and in the immediate vicinity of the school and community learning centres. The programmes are also expected to ensure that target stakeholders have access to supplies of safe, affordable, locally available, and nutritious foods as well as clean water and environment. SEAMEO RECFON believes that having practical and easy to implement policies to create an environment conducive to practicing good health and nutrition habits in schools and community learning centres among its stakeholders is critical for the programmes. The information system is meant to facilitate the creation of a communication platform for sharing, monitoring, and evaluating programme experiences and lessons learned for improvement and eventual scaling up.

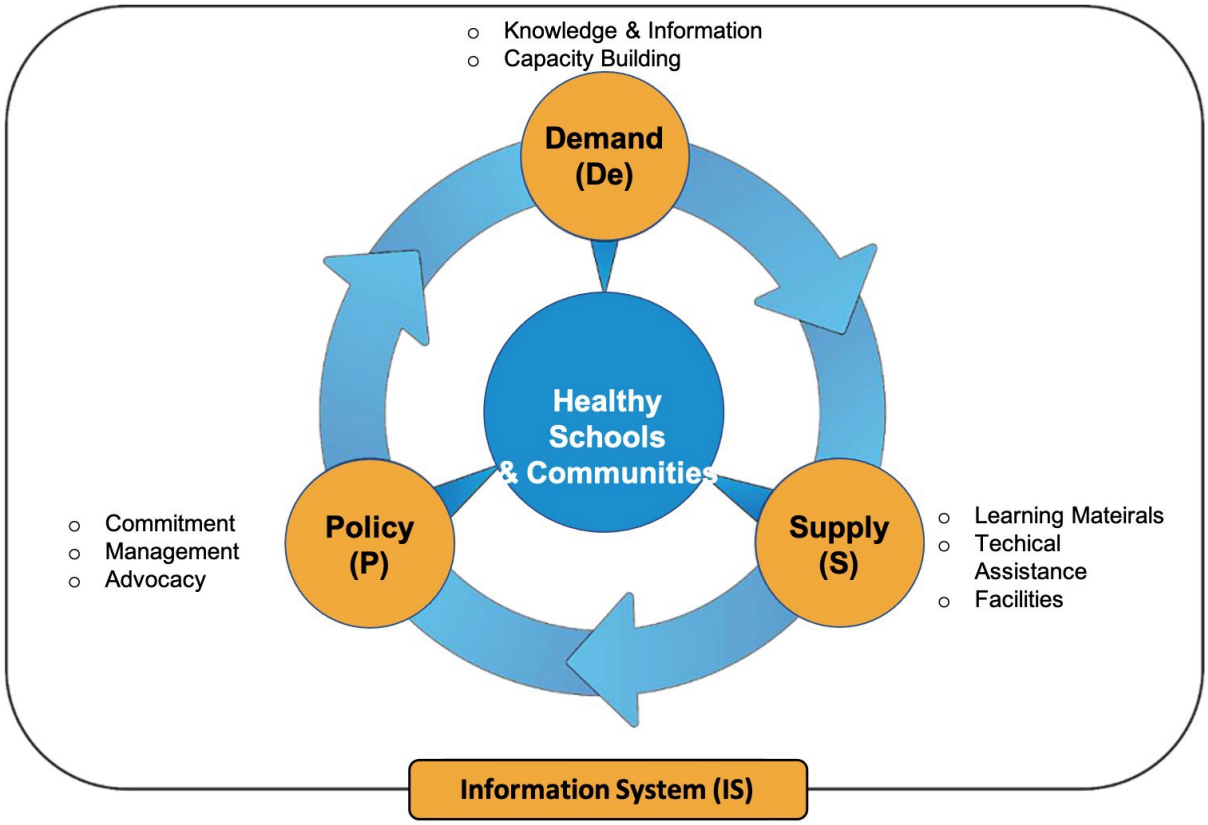

Figure 1. *The DSPIS Framework for NGTS and ECCNE Programmes*

Interventions

The activities of ECCNE and NGTS programmes are a combination of nutrition-sensitive and nutrition-specific interventions. These interventions are carried out through community development, capacity building, knowledge management, and research mandates of the Centre.

Coverage

SEAMEO RECFON is currently piloting the two flagship programmes in Indonesia. The ECCNE Programme is being piloted in four sites in Indonesia, namely: Malang in Central Java Province, Sambas in West Kalimantan Province, East Lombok in Nusa Tenggara Province, and Jambi in Central Sumatra Province. It involves early childhood education (ECE) teachers, community health workers and mothers for nutritional development of under-five children. The NGTS Programme is being implemented in six sites, namely: Sambas in West Kalimantan Province, Klaten in Central Java, Malang in East Java Province, and Bogor, Cimahi and Cirebon in West Java Province. It involves school teachers and principals, local education and health officers, and academic institutions for nutrition literacy of primary, secondary, and vocational school children. The NGTS Programme is expected to end its piloting period in Indonesia in 2021 while the ECCNE Programme in 2022.

Several efforts have been made to initiate the implementation of NGTS and ECCNE Programmes in other Southeast Asian countries. These countries include Cambodia, Lao PDR, and Myanmar for ECCNE Programme in 2018 and Timor-Leste for NGTS Programme in 2019. Both programmes have been endorsed by the 11 Ministers of Education of Southeast Asian countries for scaling up during their 50th annual SEAMEO Council Meeting in July 2019 in Kuala Lumpur, Malaysia.

The ECCNE Programme: Ensuring Optimal Growth and Development of Under-Five Children

Early childhood development interventions, especially during the first 1,000 day in the life of a newborn, are essential in paving the way for better health and learning capacity, increased potential for livelihood generation during adulthood, poverty reduction, fewer inequalities, and more peaceful societies (Lancet Early Childhood Development Series, 2016). These interventions could include the promotion of optimal infant and young child feeding, healthy home care and nutritional support, disease prevention, management of childhood illness, and high-quality early childhood care and education (ECCE) programmes. These, however, present challenges for most national governments in Southeast Asia.

The SEAMEO RECFON's ECCNE programme is a community-based multisectoral intervention programme aimed at providing a model of integrated implementation of essential components of childcare and parenting to ensure optimal psychomotor, cognitive and affective growth and development of a child. It is a collaborative endeavour with two other SEAMEO Centres, namely: the Regional Centre for Early Childhood Care Education and Parenting (CECCEP) and the Regional Centre for Tropical Medicine (TROPMED) Network.

The ECCNE Programme was conceptualised in 2017 but full implementation began in 2018. Its framework has five components that are necessary to achieve an integrated approach to optimal child growth and development (Figure 2). These are arranged in a form of a house that represents a family, a household, a school, or a community where they could and should operate. A house is supposed to serve as a nurturing environment for a child's growth, development, and security.

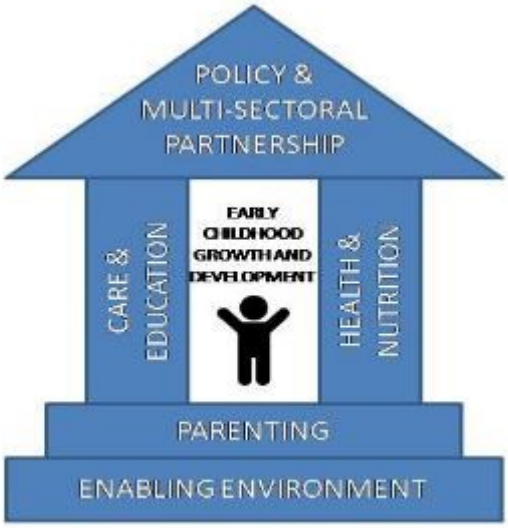

Figure 2. *ECCNE Programme Framework*

Specifically, the program aims to:

1. Formulate strategies, approaches and guidelines for each program component and integrate them to form a single ECCNE model;
2. Generate evidence of the effectiveness of the strategies and approaches for each component;
3. Advocate the use of the ECCNE model to relevant stakeholders for adoption;
4. Build the capacity of stakeholder to implement the ECCNE model; and
5. Establish mechanisms for the sustainable implementation of the ECCNE model

The ECCNE Programme has a set of activities that are categorized into nutrition-sensitive and nutrition-specific according to the DSPIS Framework as shown in Table 1.

Table 1. *ECCNE Programme Activities.*

Classification in DSPIS	Nutrition-Specific	Nutrition-Sensitive
Demand	• Generation and implementation of food-based recommendations for under-two years children from locally available nutrient-dense food sources • Supplementary feeding	• Learning Module Development • Capacity Building of Early Childhood Educators, Parents and Community Health Workers on ECCNE • ECCNE Working Group Formation and Functioning
Supply		• ECCNE Working Group Formation and Functioning
Policy	-	• Advocacy to mainstream ECCNE through partnership with local governments and academic institutions in programme sites • ECCNE Working Group Formation and Functioning
Information System	-	• Online Mapping of Early Childhood Educators' Competencies on ECCNE • ECCNE Working Group Formation and Functioning

In Indonesia, the ECCNE Programme supports the Presidential Regulation No. 60 of 2013 on Integrative Holistic Early Childhood Development as well as the National Strategy on Accelerating Stunting Prevention 2018-2024. After two years of implementation, the ECCNE Programme had accomplished the following per activity type:

1. Online mapping of early childhood educators' competencies in ECCNE
   A total of 17,821 early childhood educators in 484 out of 514 districts (94%) across all provinces of Indonesia have been surveyed on their ECCNE competencies in October 2018. Interestingly, 77.3% of these early childhood educators have not received any training on nutrition which provided the strong justification for SEAMEO RECFON to conduct a series of capacity building activities in the ECCNE programme sites.
2. Capacity building of early childhood educators, community health workers and mothers on ECCNE
   a. Training of eight nutritionists and healthcare staff from two districts, 80 cadres and 480 mothers with under-two aged children on stunting prevention in February 2019 and March 2019 in Malang City and Sambas District, respectively.
   b. Training of 36 early childhood educators from 18 ECE centres in Sambelia and Pringabaya Subdistricts, East Lombok District and West Nusa Tenggara District on ECCNE in disaster-prone areas in February and April 2019.
   c. Training of 21 Master Trainers from Sambas, Malang and Tanjung Jabung on ECCNE under the concept of Holistic-Integrative Early Childhood Education in September 2019.
   d. Training of Trainers on ECCNE under the concept of Holistic-Integrative Early Childhood Education for 78 early childhood educators from Sambas and Tanjung Jabung in September 2019.

3. Development of ECCNE learning materials.
   a. Two learning modules have been developed and published, namely: ECCNE for Stunting Prevention in February 2019, and Guidelines for ECCNE in Disaster-Prone Areas in April 2019
   b. A series of nine modules on Holistic and Integrative Early Childhood Care Education have been finalised for printing in February 2020.

4. Establishment of ECCNE Models.
   Three ECCNE models have been established, namely:
   a. Health Centre-based ECCNE Model for Stunting Prevention in Malang and Sambas Districts starting in 2018.
   b. ECCNE Centre-based ECCNE Model for Stunting Prevention in Malang, Sambas and Tanjung Jabung Districts starting in 2019.
   c. ECCNE Model for Post-Disaster Recovery in East Lombok District starting in 2018.
   Another model, Daycare-based ECCNE model, has been recently conceptualised and is expected to be implemented in 2020 in Jakarta City.

5. Advocacy to Mainstream ECCNE Programme through Partnerships.
   SEAMEO RECFON signed a Memorandum of Understanding in 2018 with three academic institutions, one district government and one civil society group to implement the ECCNE Programme. These institutions include the University of Brawijaya and Malang Health Polytechnic Institute in Malang, East Java, Sambas District Government and Pontianak Health Polytechnic Institute in West Kalimantan, and the Himpunan Pendidik dan Tenaga Kependidikan Anak Usia Dini (HIMPAUDI or translated as Association of Educators and Personal on Early Childhood Education in English) which is based in Jakarta. SEAMEO RECFON has formulated a policy brief

in 2019 on its research on the formulation of local specific food-based recommendations (FBR) for stunting prevention in ECCNE Programme sites and had submitted it to the Ministry of Health of Indonesia for consideration. Details of the research are discussed under No. 7.

6. ECCNE Working Group Formation and Functioning.
   The ECCNE Programme has created its Indonesian Working Group on 9 July 2019 whose members come from government education and health agencies, academic institutions, civil society groups, and research organisations including SEAMEO RECFON. The Working Group is expected to carry out a mapping of competencies of early childhood educators, develop ECCNE learning materials and models, and document ECCNE best practices.

7. Formulation of local specific food-based recommendations (FBR) for stunting prevention in ECCNE Programme sites.
   Using linear programming approach through Optifood software, the ECCNE Programme team developed and tested the optimised local specific food-based recommendations (FBRs) among 240 under-five age children in two sites (i.e. Malang and Sambas) as an intervention group for six months in 2019 and compared the results with another 240 under-five age children as a control group (Figure 3).

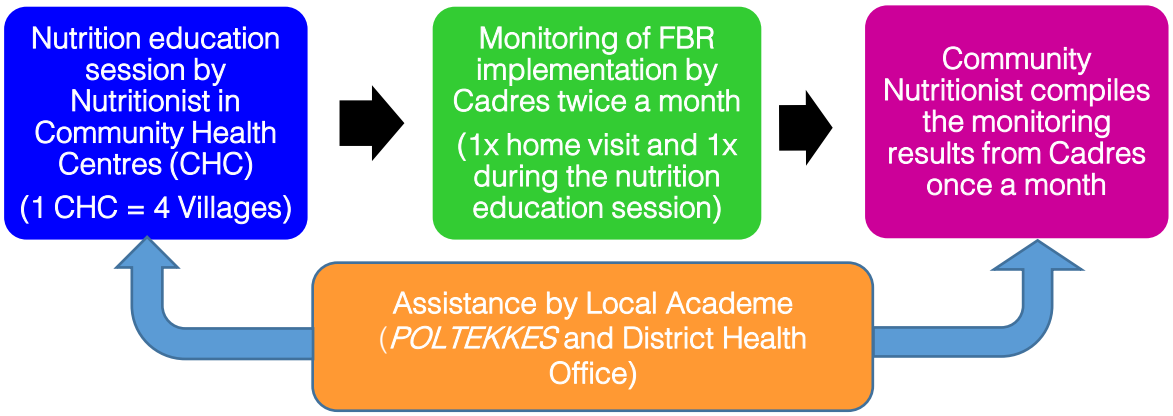

Figure 3. *Implementation Scheme of Food-based Recommendation Promotion And Nutrition Education in Two ECCNE Programme Sites for Six Months*

The study showed positive benefits in terms of an improved dietary diversity score and nutrient intakes among children in the intervention group. Additionally, the positive and significant benefit of Complementary Feeding Recommendation (CFR) in terms of anemia and linear growth was observed in the Sambas district in West Kalimantan Province where the ratio of animal protein from animal source foods (ASF) to plant protein is 3:1 as compared to Malang where the ratio is 0.9:1.

At the end of six-month promotion of optimized FBRs in Sambas, significant differences were found among children under control (C) and intervention (I) groups in terms of stunting cases (C=33.5%, I=23.9%) and anaemia cases (C=43.5%, I=23.9%).

In 2018-2019, the ECCNE Programme Coordinator and team members have been providing technical assistance to the Ministries of Health of Cambodia, Lao PDR, and Myanmar in formulating FBRs for under-five age children.

The NGTS Programme: Developing AWESOME School-Aged Children

The NGTS Programme targets school-aged children because it is in this period when eating habits are developed and/or acquired either within or outside the household and school environments that could affect their nutritional status later during adulthood. Thus, it is the opportune time to help improve the dietary behaviours of this group of children. The programme aims to develop AWESOME (i.e., Active, Well-Nourished, and Smart Of Me) school children that is expected to be manifested in their school performance both in class and extracurricular activities. An active student means performing any form of physical activity everyday in a week for at least 30 minutes per day as recommended by the Ministry of Health of Indonesia (2014). A student is well-nourished if his/her body mass index (BMI) fall in the normal range as indicated in the growth standards published by WHO (2006).

Being smart is measured through the improvement in the academic performance of the students in class. The Programme framework has three components, namely: nutrition education, policy and management support, and school environment (Figure 4).

The Policy and Management Support component refers to the existing school-related regulations and those that need to be developed as well as decision-making processes to make the school environment and curricular activities address the health and nutrition needs of school children. The school environment component refers to the socio-physical environment and the different interactions taking place within the classroom, within the school campus, and within the immediate vicinity outside the school. The nutrition education component refers to the integration of nutrition concepts and principles in both the classroom and extracurricular activities of the students in relation to their school environment and policy and management support situations. These components are expected to play critical roles when integrated in both classroom and extracurricular activities of school children to become AWESOME.

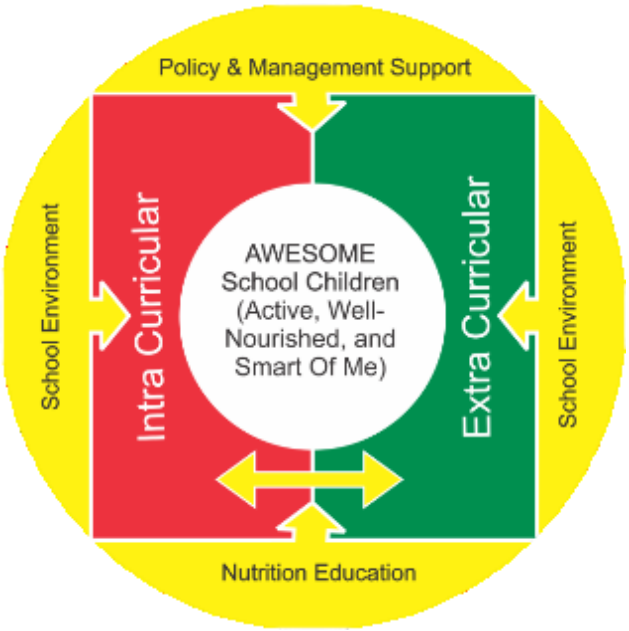

Figure 4. *NGTS Program Framework*

The NGTS Programme has a set of activities that are categorized into nutrition-sensitive and nutrition-specific types according to the DSPIS Framework as shown in Table 2.

Table 2. *Nutrition-Specific and Nutrition Sensitive Activities of NGTS Programme*

Classification in DSPIS	Nutrition-Specific	Nutrition-Sensitive
Demand	• Generation and implementation of food-based recommendations from locally available nutrient-dense food sources for adolescent female school children	• Learning module development • Capacity building of school teachers, local government education officials on nutrition education and WASH education • Continuous technical assistance via social media • Establishment and functioning School-Based Nutrition Promotion (SBNP) Working Groups for Indonesia and Southeast Asia
Supply		• Establishment of School Garden • Establishment of Health School Canteen • Monitoring of Implementation of IFA Supplementation • Establishment and functioning of School-Based Nutrition Promotion (SBNP) Working Groups for Indonesia and Southeast Asia
Policy	-	• Advocacy to mainstream NGTS Programme in schools in partnership with local governments and academic institutions in programme sites • Establishment and functioning of School-Based Nutrition Promotion (SBNP) Working Groups for Indonesia and Southeast Asia
Information System	-	• Mapping of school readiness to implement NGTS Programme • Establishment of Southeast Asia School-Based Nutrition Promotion (SBNP) Working Group

The NGTS Programme supports several national government programmes under the Ministry of Education and Culture and the Ministry of Health of Indonesia such as the *Usaha Kesehatan Sekolah* (UKS or School Efforts for Health), the *Program Sekolah Sehat* (or Healthy School Programme), the *Adiwiyata* (or Green School Programme), the *Program Gizi Anak Sekolah* (ProGas or School Feeding Programme), etc.

After three years of implementation, the NGTS Programme had accomplished the following:

1. School Readiness Mapping for NGTS Implementation

The Programme sampled 664 schools (i.e. 74% government and 26% private) from different levels from the major islands of Indonesia in 2017 in relation to their readiness to implement the NGTS Programme according to the DSPIS framework. The results showed that around 78% of the schools surveyed were ready to implement an NGTS Programme. This enabled SEAMEO RECFON to identify and implement NGTS in certain programme sites.

2. Learning Module Development

From 2017 to 2018, the NGTS Programme developed five learning modules, namely:

a. *Gizi dan Kesehatan AnaK Usia Sekolah Dasar* (Health and Nutrition for Primary School Children)
b. *Gizi dan Kesehatan Remaja* (Health and Nutrition for Adolescent School Children)
c. *Panduan Gizi Seimbang untuk Remaja* (Balanced Nutrition Guide for Adolescent School Children)
d. *Kantin Sekolah Sehat* (Health School Canteen)
e. *Edukasi Gizi Berbasis Kebun Sekolah* (Nutrition Education Based on School Garden)

3. Capacity Building of School Teachers and Piloting of NGTS with Partner-Schools

The NGTS Programme had conducted Training of Trainers (face-to-face mode) for 396 teachers from 114 partner-schools at all levels from six NGTS Programme sites (i.e., Sambas, Malang, Cirebon, Bogor, Klaten, and Cimahi) on nutrition, hygiene and sanitation education. It had also trained 993 teachers from 105 schools via an online mode. Both training modes required the participants to formulate action plans to implement some or a combination of NGTS activities (i.e., nutrition education, school garden, school canteen, physical activities, WASH) in their respective schools.

4. Advocacy to Mainstream NGTS Programme through Partnerships

Between 2018 and 2019, SEAMEO RECFON signed a Memorandum of Understanding with seven Health Polytechnic Institutes and one state university for implementation of NGTS Programme in Bogor, Cimahi and Cirebon Districts in West Java, Klaten District in Central Java, Malang City in East Java, and Sambas District in West Kalimantan. Two partner-schools in Bogor sought to formalise their partnership with SEAMEO RECFON by signing an MOU in 2019.

5. Monitoring the Implementation of Iron Folic Acid (IFA) Supplementation under the *Aksi Bergizi* (Adolescent Nutrition) Project of UNICEF

Since NGTS Programme targets adolescent school children, SEAMEO RECFON has been selected by UNICEF as its partner-institution to carry out its Aksi Bergizi Project which includes the monitoring of the implementation of IFA supplementation among secondary school children.

Impacts Thus Far of SEAMEO RECFON's NGTS and ECCNE Flagship Programmes

The ECCNE Programme

1. With the ECCNE Programme experiences in developing learning modules,
   a. the Ministry of Education and Culture of Indonesia has endorsed the new set of nine modules on Holistic and Integrative Early Childhood Care and Education that the programme team developed in 2019. The endorsement comes in the foreword from the Directorate General of Early Childhood and Community Education. The modules are now accessible from SEAMEO RECFON website.
   b. the Ministry of Health of Indonesia requested SEAMEO RECFON's ECCNE Programme Team to develop three guidelines on stunting prevention for District/City Governments, Community Health Centres (*Puskesmas – Pusat Kesehatan Masyartakat*), and Integrated Family Planning and Health Service Centres (*Posyandu – Pos Pelayanan Keluarga Berencana dan Kesehatan Terpadu*). The first drafts are expected to be ready before the end of 2020.

2. The Ministry of Health of Indonesia has accepted, in principle, the recommendations contained in the policy brief developed by the ECCNE Programme resulting from the research on formulating local specific food-based recommendations for under-five aged children for stunting prevention in Sambas and Malang sites in 2019.

3. Two other district governments sought to formalise a partnership with SEAMEO RECFON to strengthen the implementation of the ECCNE model on stunting prevention. The Centre already signed a Memorandum of Understanding with the District Government of East Lombok in Nusa Tenggara Province, and Tanjung Jabung East SubDistrict in Jambi Province.

4. With the ECCNE Program team expertise and experiences in formulating local specific food-based recommendations for under-five age children, the Ministry of Health of Indonesia, through funding support from Global Alliance for Improved Nutrition (GAIN) and the Government of United Kingdom, had requested SEAMEO RECFON to train local academe of 37 priority districts for stunting prevention on formulating local specific FBRs for their respective localities.

5. The Ministry of Religious Affairs of Indonesia and SEAMEO RECFON agreed to allocate slots for teachers of Islamic schools under the Ministry to join the online course on ECCNE in March and April 2020 for Early Childhood Teachers in implementing the concept of holistic and integrative early childhood education through parenting session.

NGTS Programme

1. At least 83 schools that have received training on NGTS (face-to-face and online modes throughout Indonesia) joined SEAMEO RECFON's NGTS Awards to share their best practices in integrating nutrition education concepts and principles in their lesson plans for classroom and extracurricular activities. Ten best schools were selected as winners of the awards in primary, junior, and senior/vocational school levels.

2. With the progress made by the NGTS Programme in its various sites with partner-schools under the Ministry of Education and Culture of Indonesia, the Universitas Muhammadiyah and the Muhammadiyah Organization of Indonesia sought the partnership of SEAMEO RECFON to initiate the same programme to Madrasah or Islamic schools in Jakarta City by conducting a training for at least 20 school teachers by mid 2020.

3. Some partner-schools have become finalists for the Healthy School Award at district/city, provincial and national levels. In Cirebon site, two primary schools became finalists at the district/city level, one junior high school at the provincial level, and one junior high school at the national level in 2019. In Sambas, one junior high school is a finalist at the national level for 2020.

Some Lessons Learned in Implementing SEAMEO RECFON's ECCNE and NGTS Flagship Programmes

SEAMEO RECFON generated the following lessons learned in implementing its flagship programmes on ECCNE and NGTS:

1. Painting the bigger picture of the NGTS and ECCNE Programmes including their relevance to global protocols and national policies and programmes is critical to obtain the buy-in of stakeholders.

2. Clarifying the specific roles of partners, emphasizing shared ownership of the programmes, and formalising the partnership help facilitate programme implementation.

3. Support/Endorsement from top provincial/district government officials helps ensure programme sustainability and wider coverage of implementation.

4. Using existing national government programmes as one entry point which can boost the relevance and acceptance among partners.

5. Research results provide for better evidence/informed-based decision making from among the partners involved thus strengthening their commitments to the programmes.

6. Selection of schools by district education offices and consensus with academic partner-institutions enhances programme ownership and commitment to implement planned activities.

7. Encouraging academic and government partners to integrate NGTS and ECCNE programmes in their regular activities could help reinforce implementation.

8. Sustained and timely technical assistance to school teachers, ECE teachers, and community health workers is critical to ensure the achievement of programme objectives and targets.

9. Aside from the face-to-face monitoring, the proper use of social media maintains continuous communication, sharing of experiences, and documentation of progress between and among partners.

10. Providing proper recognition of efforts by school teachers/EC educators deepens their personal and school advocacy to promote NGTS and ECCNE activities.

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STEM Learning and Industry 4.0 as a Vehicle for Climate Change Impact Mitigation

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Abstract

In the past years, digital technologies, such as cyber-physical systems, artificial intelligence, big data, augmented and virtual reality, and 3D-printing, have entered the sphere of industrial production and given rise to the notion of a “fourth industrial revolution” or “Industry 4.0”. Other than this opportunity, the Global Risk Report stated that there are also threats risking the development of industry 4.0 in the future. Out of five risks, four are related to climate change. Southeast Asia, particularly Indonesia, which is an archipelago country, is vulnerable to impacts of climate change. This research paper reviews many findings from various resources such as recent reports, published journals, and institutional publications. It found that STEM learning can facilitate students to develop climate literacy as well as an increase of 4C skills to develop innovation to overcome climate change issues and fulfil the objectives in the SDGs.

Keywords: Climate change, digital transformation, STEM education, sustainable development

Introduction

Industry 4.0 is the proliferation of cyber-physical systems that introduces the fourth stage of industrialisation. It includes cyber-physical systems, the Internet of Things, Cloud Computing, and Cognitive Computing. Industry 4.0 is commonly referred to as the fourth industrial revolution (Wang et. al., 2016). Industry 4.0 creates what has been called a “smart factory”. Over the Internet of Things, cyber-physical systems communicate and cooperate with each other and with humans in real-time both internally and across organisational services offered and used by participants of the value chain.

Although there is a growing body of evidence reporting adoption of the Industry 4.0 paradigm and the attendant technologies and processes, the Global Risk Report stated that there are also threats risking the development of industry 4.0 in the future. Out of five risks, four are related to climate change (World Economic Forum, 2019). Climate change has already changed the magnitude and frequency of extreme weather events as it is a key causative factor in increased heat waves, flooding, droughts, intense tropical cyclones, rising sea levels, and loss of biodiversity. These hazards increase the vulnerability to disasters and result in widespread human, material, economic and environmental losses (IPCC, 2012).

The impacts of climate change on people's livelihoods have been widely documented (IPCC, 2012). It is expected that climate and environmental change will hamper poverty reduction, or even exacerbate poverty in some or all of its dimensions. Changes in the biophysical environment, such as droughts, floods, water quantity and quality, and degrading ecosystems, are expected to affect opportunities for people to generate income. These changes, combined with a deficiency in coping strategies and innovation to adapt to particular climate change threats, are in turn likely to lead to increased economic and social vulnerability of households and communities (Szabo, et al., 2016).

While there is an emerging awareness of the current and potential impacts of climate change on education provision and learning, it is also clear that education has an important role to play in addressing this change. This includes work carried out using various terms and definitions, including 'education for sustainable development' or ESD (Sterling, 2001).

In 2015, the United Nations Development Programme (UNDP) identified a series of seventeen important worldwide goals referred to as the Sustainable Development Goals (SDGs). These goals make up a blueprint for the future well-being of the globe oriented around the themes of people, planet, prosperity, peace, and partnership (United Nations, 2019). The UN Sustainable Development Goals (SDGs), assign technology an important role in achieving climate change mitigation and sustainable development (United Nation, 2015). Education is a crucial part of the SDGs, not only due to its role as a specific goal (Goal 4: Quality Education) but also because it is essential to the possibility of progress on all goals, including climate and environmental-related goals (UNESCO, 2014).

Young people and their teachers and parents need to be helped to obtain environmental and scientific literacy by inoculating a powerful and sustained implementation of future-oriented science, technology, engineering, and mathematics (STEM) learning focused on the issues of critical importance as those outlined in the UN SDGs against societal and health problems such as climate change that can adversely affect their lives (O'Donnell, 2018). STEM education can be identified as one of the new approaches to be used in the education system, which also aims for students to be able to solve problems in their daily lives.

Consequently, the question that this paper aims to address: how does STEM learning along with digital transformation enhance students' creativity in mitigating climate change impact?

Methodology

To answer the questions, the authors conducted an extensive literature review. The literature review underlies the questions that will be adopted by the researchers. It comprised a critical qualitative analysis of one or more themes that have already been published. It is up to researchers to search, collect, prioritise, read with purpose, look for key issues and themes, and then describe and criticise them (Klopper et al., 2007).

The review applies a two-tier approach (Figure 1): First, researchers analyse relevant international government institution publications to identify trends and current issues in the

global community regarding potentials and threats on future development and their policies and strategies in facing these matters.

In the second part of the analysis, researchers conduct a review of peer-reviewed journal articles on STEM learning to improve climate literacy and 4C skills in connection with digital transformation in industry 4.0 and climate change mitigation. Finally, researchers compare their findings to identify meaningful conclusions to further inform policymaking as well as research in the field of STEM learning and climate change mitigation.

Findings and Discussions

Digital Transformation in Industry 4.0

The presence of the Internet of Things nowadays will be felt in every area. In some, such as energy supply, mobility, and health, smart grids are already formed. In manufacturing, increasingly intelligent products and systems are creating the fourth stage of industrialisation – Industry 4.0 (Kagermann et al., 2013).

Industry 4.0 will involve the technical integration of cyber-physical systems (CPS) in every aspect especially in manufacturing and logistics, and the use of the internet of things and services in the processes. This will have implications for value creation, business models,

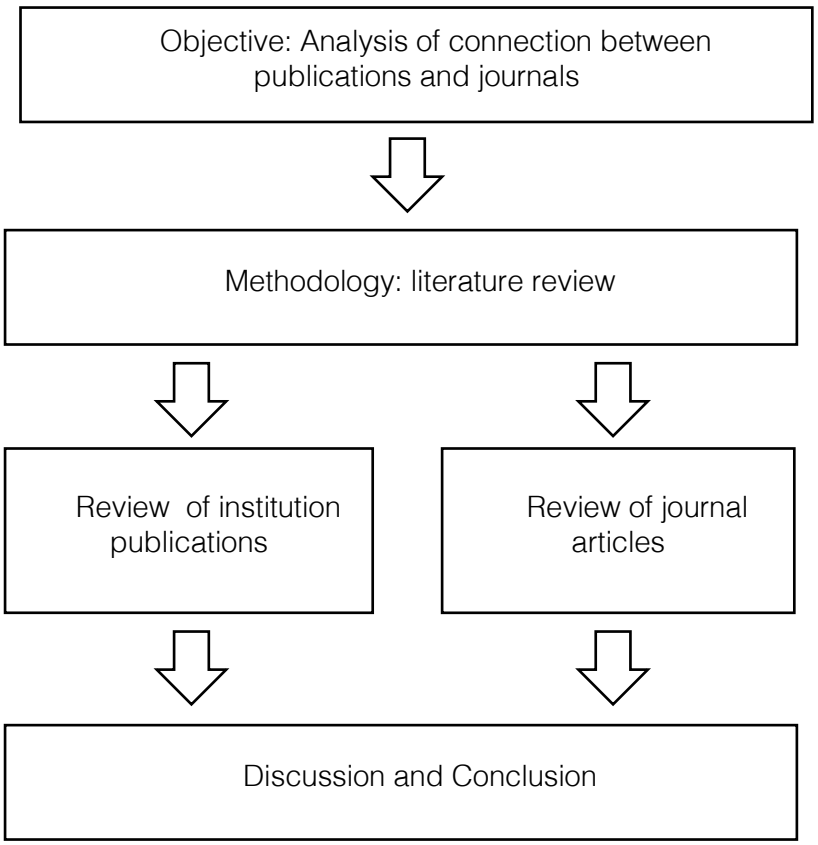

Figure 1. *Overview of the research approach*

production lines, and work organisation. Industry 4.0 will be able to promote transformations in various areas of manufacturing and especially throughout the value chain and the way companies relate to their customers. The development of Industry 4.0 will strengthen the

competitive position of many countries, especially the most developed ones, but will also make it possible to create solutions to many global challenges such as energy efficiency and resource use (Kagermann et al., 2013).

In connection with climate change impact, the authors found that digital transformation in Industry 4.0 will be able to make progress on environmental issues. It will substantially increase the efficiency of land, water, and raw materials used as well as energy efficiency and food production. As stated by Porter and Heppelmann (2014), these relevant advances will contribute to the improvement of the human condition, especially in health, safety, mobility, and education.

Digital Transformation in STEM Learning for Sustainable Development

Research on the use of digital technology and diversity in STEM learning shows that these technologies are effective in developing key skills and better learning for students. Technology is increasingly accessible, intuitive, reliable, and diverse in its application, and it is becoming possible for each student to be educated in a way and at a pace that suits his or her abilities, interests, and needs (Barak, 2014).

In STEM Learning, digital technology can also serve as tools for creating learning communities (Berenfeld, 2010), for enhancing conceptual understanding, and for promoting higher-order thinking skills among students (Barak, 2014).

STEM learning also encourages students to participate in the social processes of searching, learning, and shaping in order to solve global sustainability issues and to critically reflect on their contribution to sustainable developments. STEM knowledge and the processes of science can help students understand global problems and support actions in society and address them in a meaningful and knowledge-based way (Pahnke et al., 2019).

Inquiry-Based Science Education (IBSE) and more recently “Inquiry-Based STEM Education" with digital technology enhancement allows students to explore ‘hands-on’, to experiment, to ask questions, and to develop responses based on the reasoning in addition to solving problems, and understanding the phenomena of the real world around them (‘minds on’), just as scientists and engineers do. Exploration and exploration-based and inquiry-based learning are paths to knowledge for students, on which they can build up knowledge and skills. (O’Connell, 2014).

Besides conceptual knowledge, an essential part of basic education in the STEM enhanced with digital technology is the ability to acquire, expand, critically reflect on, and apply knowledge using suitable methods of thinking and acting. This includes the ability to work out fundamental relationships for oneself, to evaluate these relationships, and to make decisions based on them, and also, to develop skills in using the ICTs (Haus der kleinen Forscher Foundation, 2016).

From all the above, it can be understood that STEM learning with a focus on Education for Sustainable Development (ESD) with digital technology enhancement can encourage changes in knowledge, skills, values, and attitudes to enable a more sustainable and just society for all. It aims to empower and equip current and future generations to meet their needs using recent effective tools and a balanced and integrated approach to sustainable development.

A STEM Project to Mitigate Climate Change Impact

There has long been a desire to connect academic science to real-life situations (Hurd, 1998), not only to capture the interest of students but to enable those students to apply the

knowledge and skills they gain to effectively contribute to society. This is derived from the definition of a scientifically literate person as one who can apply their understanding of science and the scientific processes to solve problems and address societal issues. However, this transfer of knowledge and skills to practical situations outside of the context in which it is taught is not always achieved (Hurd, 1998).

Understanding climate change initially required the development of scientific research programmes that bridged the traditional disciplinary boundaries of atmospheric science, oceanography, hydrology, geology, ecology, and environmental science to conduct interdisciplinary investigations to which all these fields could contribute. The interdisciplinary field of Earth system science grew out of this need in the late 1980s and early 1990s (Wainwright, 2009). More generally, an application-oriented perspective of science has led to a growth in collaborations across disciplinary boundaries to produce new fields of intellectual pursuit (van den Besselaar & Heimeriks, 2001) that are enriched by multiple disciplinary perspectives and analytical techniques.

A STEM project has been designed to hold students responsible for their own learning, thus, encouraging students to develop the skills they need for the 21st-century competitive world, such as technology skills, proficient communication and problem-solving (Bell, 2010).

STEM projects that help solve the climate change issues are sure to generate great interest in students worldwide. Green technology, for example, can provide an excellent way to reduce electricity use, carbon emission, and save money. Because students are assigned to solve problems related to climate change and have real-life applications, students must investigate, record, analyse, and present their findings. In short, the STEM project on climate change grants students a greater degree of freedom to discuss, test, and create their own solution (Capraro, 2013).

Based on the review, the authors proposed that climate change issues should be included in STEM projects. STEM projects in the classroom empower students to solve issues related to climate change through creating innovation by enhancing students with 21st-century skills such as creativity, critical thinking, communication, and collaboration (4C), also showing them that they can actively contribute to a better future.

Conclusion

This paper analysed the connection between international government institutions' policies to overcome climate change issues through education as a media and digital transformation in industry 4.0 as a potential enhancement.

Education is vital for climate change adaptation or reducing vulnerability to impacts that are now inevitable even if emissions targets are met. The role of education is critical in enabling informed decision-making based on projections of potential impacts, rather than relying on experience that will come too late.

Technology, specifically digital technology, plays an important role in STEM learning. Through the use of technology in STEM projects, students can learn about innovation, develop technological literacy, acquire digital skills, and learn about the effects of technology on the environment and sustainability. Students' use of technology in a self-directed way in STEM learning makes a great contribution in gaining self-regulated learning skills. Also, the adaptation of technology, may importantly, and significantly improve their creative and innovative skills. With digital technology utilisation, STEM learning supports the acquisition of skills for the 21st century.

STEM learning for Sustainable Development with digital technology utilisation encourages students to draw on their STEM competence and the process of science as a key basis for reasonable action in the real world. Knowledge, skills, and understanding of science, technology, engineering, and mathematical phenomena are vital to help students understand global problems and support actions in society that address these challenges in a meaningful and knowledge-based way.

To help solve the climate crisis through education, students need to be involved. Climate Change impact mitigation is an excellent project for STEM learning in the classroom because students are familiar with climate change through the utilisation of their PCs, laptops, iPads, smartphones, and all the social media use with those devices as the application of digital transformation in Industry 4.0 era.

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The Calculator for Critical Thinking in A Mathematics Lesson: Experience With 4th Grade Students

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Abstract

There is a perception about calculator use within the school mathematics setting in that it has no purpose aside as a computing tool and can have a negative impact on the students' mathematics ability, especially in the lower educational stages. In Indonesia, using calculators in the classroom is frowned upon and it is prohibited in the examination. In this study, we attempted to answer this issue by investigating the impact of calculators on the students' critical thinking. Through design research, we developed mathematics learning materials involving calculators for 4th-grade students. The implementation of the learning materials was conducted in nine schools in Yogyakarta. The data collected in the form of video recording was then analysed according to the critical thinking framework. This paper reports the results from the first cycle of this study. The result is expected to contribute to the mathematics education literature and help to rectify the negative perception of the use of calculators in primary school mathematics.

Keywords: Technology, calculator, critical thinking, design research

Introduction

Ever since the calculator reached global use in the 1970s, its use in the school environment has been met with endless debate. The overwhelming majority of education practitioners, parents, and stakeholders fear that continuous use of a calculator will hinder the students' understanding of basic mathematical procedures and their skills acquisition, especially in lower grades (Banks, 2011). There is also concern that the use of calculators will be detrimental to their ability to perform mental computation which results in calculator dependency (Lee, 2006). The calculator is part of technology, yet the all-encompassing term of ICT, which is commonly suggested as a way to make mathematics lessons more innovative and enjoyable, often excludes calculators (Savelsbergh et al., 2016).

The widespread apprehension toward calculators manifests itself in the form of government policies. Many western countries, such as the United States, actually endorsed calculators use not only in the daily lesson but also during exams (NCTM, 2000). However, East and Southeast Asian countries are typically stricter when it comes to using a calculator in school. In Indonesia, the calculator is banned in national examinations (BNSP, 2020), even though there are no specific policies on its use in everyday classroom activities.

However, the bad reputation suffered by a calculator regarding its use in primary school is not supported by research findings. The use of a calculator in tandem with pen-and-paper exercises has been found to positively affect the students' problem-solving skills since the calculator lifts the burden of computation and lets the students focus on their problem-solving strategies (Stacey & Groves, 1994; Wheatley, 1980). The students who use calculators are also reported to possess a better attitude toward mathematics compared to those who do not use calculators (Ellington, 2003; Hembree & Dessart, 1986). Its availability and affordability are also viewed in a positive light (Kissane & Kemp, 2012).

Considering the positive findings, it seems plausible that the concern toward educational use of calculators stands on weak ground. Technology in the classroom, including calculators, does not have to make traditional pen-and-paper exercise obsolete. With the right strategy, technology can improve and reinforce it. It is up to the teachers to not see it as something to avoid and instead embrace it as a challenge.

To encourage teachers to explore the calculator's use in the classroom, further research centred on best practice is needed. One of the topics, which has not been mentioned in calculator research, is critical thinking.

Critical thinking is a very important ability, so important that it is hailed as one of the skills needed to persist in the 21st century. It is a complex subject encompassing many characteristics, such as rationality, scepticism, or unbiased analysis. Many definitions exist; one of them is by Facione (2011), which defines critical thinking as consisting of six core cognitive skills, namely interpretation, analysis, inference, explanation, evaluation, and self-regulation.

This study aims to see whether using a calculator in primary school can stimulate the students' critical thinking. The research question we attempt to answer through this study is *how does the use of a calculator support 4th-grade students' critical thinking in the mathematics classroom?*

Methodology

This study is part of four-cycle design research aimed to design learning materials incorporating calculators for primary school mathematics. Design research is an approach whose purpose is to develop theories about the process of learning and designing the means that support that learning (Gravemeijer & Cobb, 2006), which we consider suitable for the aim of this study.

Design research consists of three phases namely design, teaching experiment, and retrospective analysis (Eerde, 2013), as depicted in Figure 1.

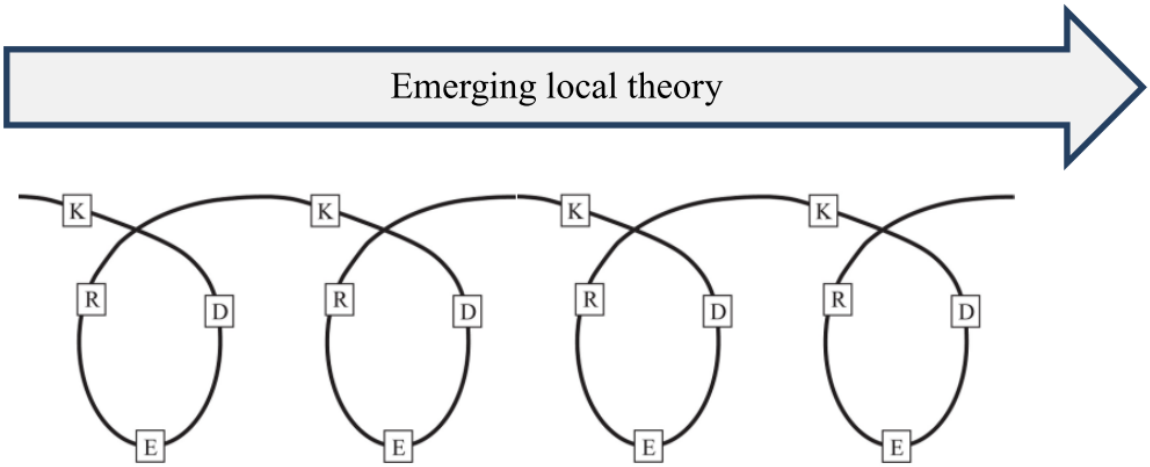

Figure 1. *Phases of Design Research*

Based on the current knowledge (K), which comprises a literature review, curriculum documents, and school textbook, the researchers design (D) learning activities. This is the Design phase. In the Teaching Experiment phase, the activities are put into practice in teaching experiments (E). In the Retrospective Analysis phase (R), the researcher reflects on the result of the teaching experiment, which contributes to new knowledge. The new knowledge then starts a new cycle. This study consists of four cycles; this article presents the initial analysis from the first cycle.

Designing classroom activities

To refute the stereotype that the calculator merely serves as computing tools, Ruthven (2003) and Kissane (2017) proposed four ways calculators can be used in the classroom that emphasize its educational purpose, namely:

1. *computation implementation* or *calculation*, which is using a calculator to perform computation otherwise impossible to perform manually,
2. *result checking* or *affirmation*, indicating the use of the calculator to confirm prediction or assess estimation,
3. *trial improving* or *exploration*, implying using a calculator as a means for students to explore several possibilities and derive conclusions, and
4. *structure modeling* or *representation*, which is using a calculator to demonstrate a numerical structure or concept.

Therefore, when designing the activities, we made sure to focus on these four strategies and to minimise the use of a calculator simply as a computing device. The example of the activities, which are in the topic of fraction representation (namely representing regular fraction as a mixed fraction and vice versa), is depicted in Figure 2. There are two parts to this worksheet; the second part follows the same structure and poses similar questions, but the problems use different numbers.

The activities are designed for 4th-grade students. According to the Indonesian national curriculum, the students in 4th grade already possess knowledge of fraction and division as an arithmetic operation which is introduced in the previous grades. However, the concept of fraction introduced in the 3rd grades is a part-whole relationship, therefore prior to the

teaching experiment, the teacher introduced the students to the concept of a fraction as division.

To bridge the students' prior understanding of regular fractions to the learning objectives which is a mixed fraction, we start the worksheet with division problems (question 1). The context introduced is about building solar panels from solar cells, in which the students have to guess by themselves the mathematics operation needed to solve the problem. This problem concludes in a division with the remainder, and when represented as a fraction, results in a larger numerator than the denominator. By the end of question 1, the students are conjectured to already identify the result and the remainder of the division.

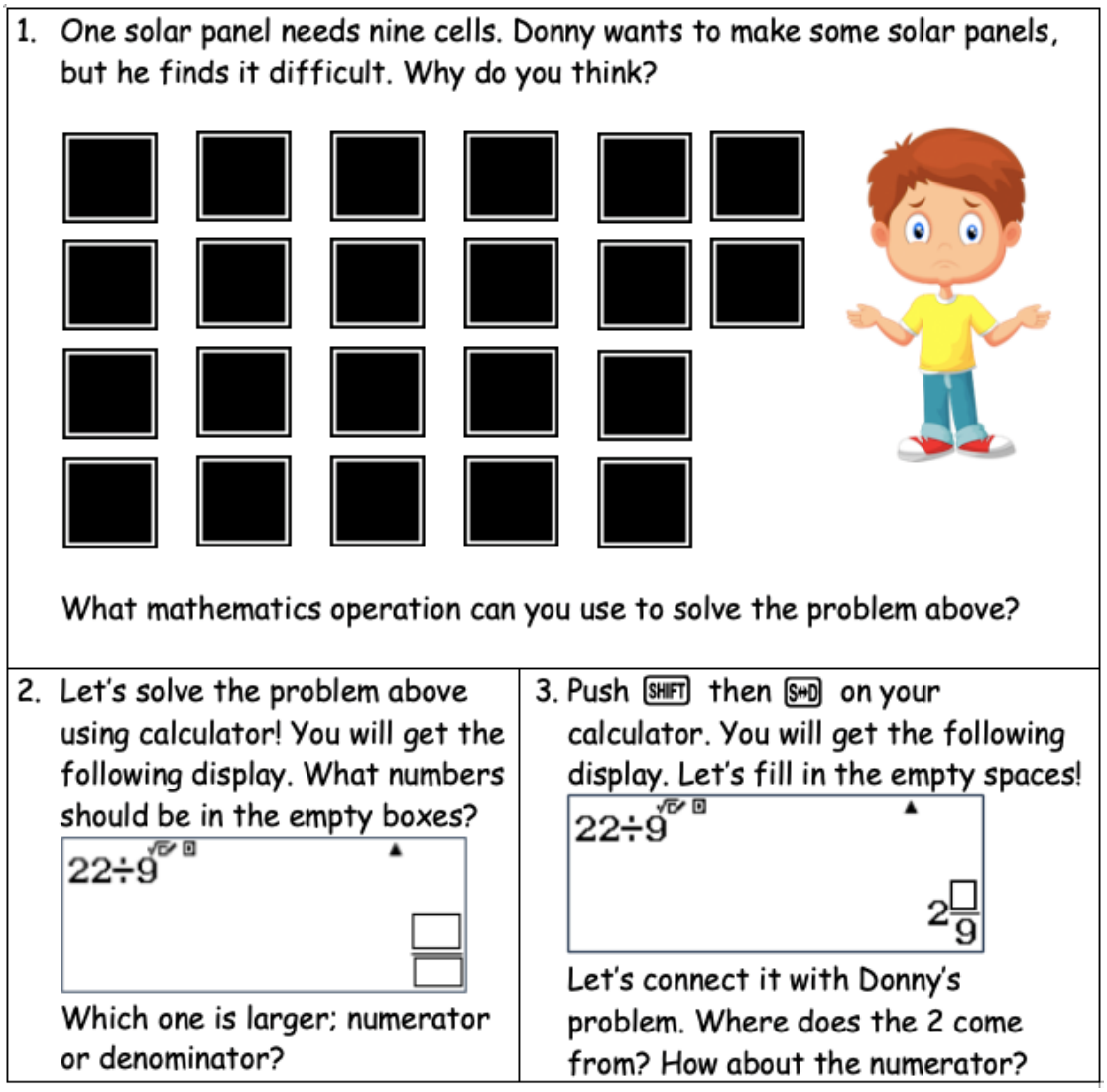

Figure 2 *Example of calculator-enhanced activities in the topic of fraction representation*

In Question 2, the students are asked to solve the problem with a calculator. However, prior to pressing the buttons, they have to guess first. We predict that the students will guess with the result and the remainder they counted in Question 1, hence the conjecture is that they will be surprised upon discovering that the calculator displays fractions. The teacher can connect this moment to their prior understanding of fractions as division. In Question 3, the students are asked to press the q then n button, resulting in the regular fraction changing to a mixed fraction.

In this part of the problem, the students use calculators for its structure modelling or representation purpose. By demonstrating how a regular fraction changes into a mixed fraction and relating it to the result of the division, the students are expected to make a connection between the result of the division and the components of the mixed fraction. Through several of these examples, the students then derive a conclusion on what a mixed fraction is and how to represent a regular fraction as a mixed fraction.

The problem used in this study is contextual and open-ended problems which encourage critical thinking because it requires students to ask questions, analyse a situation, and decide the right knowledge to apply to solve problems (Bruning, 2005). Throughout the worksheet, we incorporate many fill-in exercises to make it more interactive for the students. The students are also encouraged to use calculators with written exercises, because like their teacher, the students are also cautious about using calculators in the classroom.

Research setting

Prior to the research, all the participating teachers were enrolled in a four-day workshop on utilising calculators for primary mathematics teaching and learning. The purpose of this workshop, aside from supporting the teachers with technical knowledge about the calculator, is to also introduce how it can be used in the educational setting and to circulate the worksheet and lesson plan. The teachers also installed calculator emulators in their personal computers, to make it easier in displaying the calculator's interface to the entire class.

This study was conducted in a primary school in Yogyakarta. Twenty 4th grade students participated in the first cycle. Most come from middle to lower socio-economic classes and are familiar with calculators, yet their use is prohibited in school. The teacher who normally teaches the class taught the lesson. During the lesson, the students were split into groups of four.

Data Collection and Analysis

We collected the data in the form of a video recording of the classroom discussion. Three cameras, one static and two moving around the classroom are used to capture the classroom interaction. Not all interactions were recorded, however, since the decision on what and how to capture is somewhat influenced by the research question. Therefore, the cameras moved around the classroom capturing any group that visibly had a productive discussion, which means the video recordings are not a continuous and chronological documentation of the whole lesson. Instead, it comprises snippets of discussion and group work that potentially gives meaningful information to answer the research question.

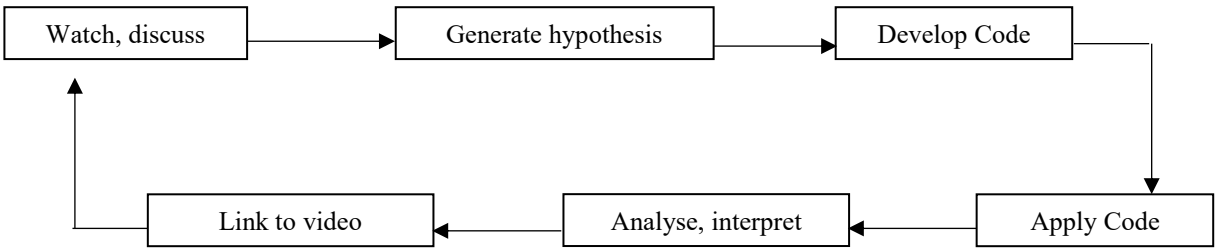

Figure 3. *The cycle of coding and analysis of video data (Jacobs et al., 1999)*

To analyse the data, we followed the cyclical process of coding and analysis developed by Jacobs, Kawanaka, and Stigler (1999) as depicted in Figure 3. First, the team of researchers watch and discuss the video to acquire the overall result of the teaching

experiment and formulate a hypothesis. Next, the researcher develops a code based on the critical thinking framework proposed by Facione (2011). Codes are tags or labels used to assign meaning to data collected during the study, to ensure the objectivity and the reliability of the qualitative data analysis (DeCuir-Gunby, Marshall, & McCulloch, 2011; Jacobs et al., 1999). Codes are not meant to stay fixed; they will be constantly revised during the data analysis. While no prior research has used Facione's framework to develop video data analysis codes, we argue that the framework is general enough to apply to any population and age group, including 4th-grade students.

The initial version of the code developed for this study is as follows.

Table 1. *Codes for critical thinking*

Code	Meaning	Description
I1	Interpretation	Comprehending and expressing the students' own understanding of the problem
I2	Inference	Identifying and securing elements needed to draw a reasonable conclusion, forming conjectures and hypothesis
A	Analysis	Identifying the intended and actual inferential relationship in the problem, either among statements or information; making the connection
E1	Evaluation	Judging and assessing the information available in the problem
E2	Explanation	Explaining the results of one's reasoning
S	Self-regulation	Relating to metacognition, self-consciously monitoring, assessing, and evaluating one's learning

The following step is applying the code to the video data. The researcher watches the video and assigning a code to the unit of analysis, namely an instance of the students' verbal or non-verbal response to the instruction, that is identified throughout the lesson. This instance can be in the form of the students' answering the teacher's question, students discussing with their peers, or the written work of the students.

The result is compiled and analysed to investigate to derive a conclusion regarding the research question. The conclusion is further compared to the video, which starts the cycle all over again. The relevant section is chosen and transcribed to support the conclusion.

Results and Discussion

While research involving video data usually transcribes the video and then analyses the transcript, due to time constraints, transcribing the whole video was deemed impractical for this study. Therefore, the code was applied to the video itself, with a timestamp linking the code to the intended vignettes of the video.

The result suggests that the majority of instances related to critical thinking in the video recording fall under Interpretation (I1) and Analysis (A). There was minimal evidence of Explanation (E2) available, as the students had a hard time formulating their thoughts, either in written or spoken words. On the other hand, no evidence is identified for Evaluation (E1), Inference (I2), and Self-regulation (S). The evidence is not universally recorded among the students; some students responded more actively to the teacher's instruction and had a more productive discussion than others.

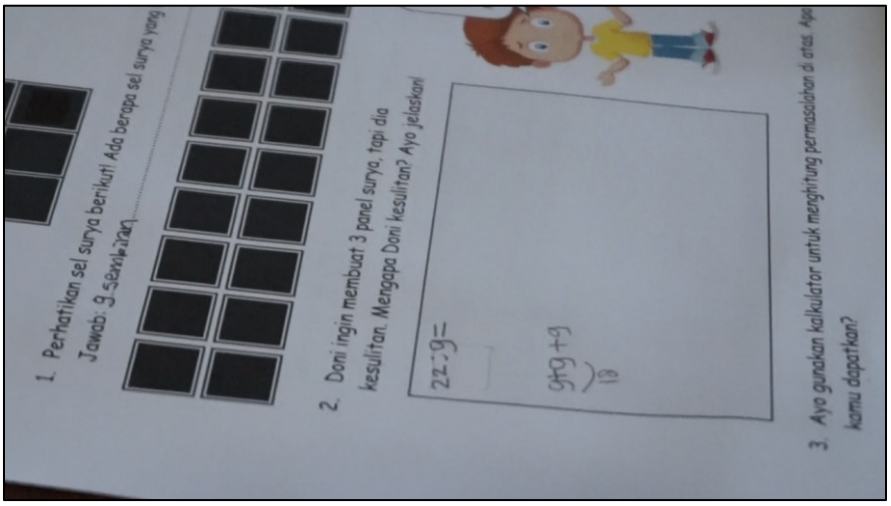

Figure 4. *The repeated addition the students did in an attempt to understand the problem*

Interpretation was identified the most frequently during question 1; both in the first and second parts of the worksheet. The students used different strategies in attempting to understand the difficulties faced by Donny. One of the strategies was repeated addition (Figure 4), in which the students add the divisor repeatedly. The student in the above picture added the divisor two times before stopping and realising what the "difficulty" was. Another strategy that appears was grouping the object, in this case, the solar cell, either by drawing or by hand (Figure 5).

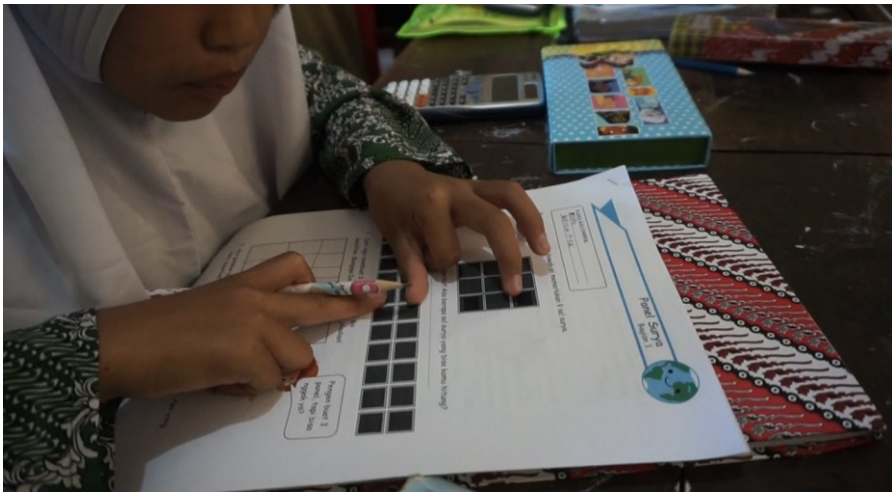

Figure 5. *The student group the objects by hand*

While almost all students could arrive at a conclusion that the difficulties faced by Donny are because there are not enough cells to make whole panels, only a few students could interpret that division was the mathematics operation needed to solve the problems.

On the other hand, Analysis is identified mostly in Question 3. Initially, the students were having difficulty identifying the previously unknown mixed fraction, with some students only mentioning the fraction part. The following excerpt (Fragment 1) depicts a whole-class discussion on this question.

Fragment 1

1 Teacher: … now the number on the screen is 22/9. What number is this?
2 Students : Fraction!
3 Teacher : Now we are going to learn using his calculator. Let's push the q button – this one – and then n. If we push enter, what do you think we are going to get?
4 Students : [inaudible]
5 Teacher : let's try, shall we? One, two, three … what do we get?
6 Student A : Four-over-nine?
7 Student B : Four-over-nine!
8 Teacher : Really? Come on, how should we read it?
9 Student C : There is a four … four over …
10 Student D : Two, four-over-nine?
11 Teacher : How should we read it? Two …
12 Student B : … four-over-nine!
13 Teacher : That's correct, we should read it two four-over-nine. But why two? How does it connect to your previous calculation? Two four-over-nine, how come?
14 Student B : The two comes from there [pointing to the board] the division
15 Teacher : This one?
16 Student B : and the four comes from the remainder. And the nine is the divisor
17 Teacher : that is correct!

There is evidence that by connecting the calculator display to the result of division calculated previously, some students are able to conclude that the whole number denotes the result of the division, while the numerator denotes the remainder.

Conclusion

In this section, we discuss how the design of activities contributes to the findings regarding cognitive skills related to critical thinking found in the video. According to the results discussed in the previous section, it was evident that the cognitive skill related to critical thinking that occurred with the use of a calculator was Analysis. Another cognitive skill that implied critical thinking emerged too, such as Interpretation, however, it mostly coincided with a non-calculator question.

Some explanations might shed light on this phenomenon. Critical thinking is learnable, even with young children. Open-ended problems that do not provide any clues about mathematics concepts needed to solve them are often cited as beneficial for higher-order thinking skills or HOTS (Fong, 2000), however associating activities are also suggested strategies to develop critical thinking of young learners (Rahman, 2014). In Question 2, where the students use the calculator as a means of representation, the calculator itself supports the students to make a connection between the result of division and the representation of a mixed fraction. Therefore, the use of a calculator in primary school can support the students' critical thinking, specifically via analysis skills, through its Structure Modelling or Representation purpose.

We suggest future research to venture into other purposes of calculators and other cognitive skills in critical thinking, as well as the connection between the two. The use of calculator in primary school mathematics is still an interesting idea which is rarely explored; hence it is still potential for the future researcher. However, we also suggest future researchers explore other mathematics content.

Lastly, this study is not without limits. We acknowledge the small sample and the limited timeframe as the main drawbacks of this study. Future researchers are encouraged to conduct longer studies with a larger sample.

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Channelling Agriculture Innovation Transfer from Universities and Research Centre to Vocational High Schools: Lesson Learned from Indonesia

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Abstract

SEAMEO BIOTROP has been assigned by the Ministry of Education and Culture of the Republic of Indonesia to revitalise secondary vocational high school in agriculture for the last three years. There were three main programmes, i.e. fruit tree gardening, food security, and the establishment of a teaching factory. The activities include training, field implementation, and supervision. There were 46 schools that have been selected for the implementation of fruit tree gardening, and 80 schools have been involved in the food security and teaching factory programmes. This has been a successful programme, where the capacity of the headmasters, teachers, and students have improved. SEAMEO BIOTROP has not only transferred innovation developed by the Centre but also involved universities (IPB University) and an agriculture research centre (Orange and Sub-tropical Fruit Research Centre under the Ministry of Agriculture) in implementing the programme. Most of the partner schools have implemented the technology introduced by SEAMEO BIOTROP and partner institutions in their schools and the surrounding farms. The SEAMEO BIOTROP scientists have developed an application to monitor the progress of the schools and also to sustain long-distance consultation. The programmes have shown that secondary vocational high schools in agriculture have the potential to be developed as a transfer technology hub in agriculture for their surrounding communities and farmers. Skill development in industry 4.0 in the area of agriculture could also be introduced to selected schools in the future.

Keywords: BIOTROP, fruit garden, Industry 4.0, SEAMEO, Vocational school

Introduction

SEAMEO BIOTROP has succeeded in establishing the School Garden Programme in Indonesia, which was initiated in March 2016 as part of SEAMEO College Research 6: A Participatory Action Research programme on School and Community-based Food and Nutrition Programme for Literacy, Poverty Reduction and Sustainable Development began with funding support from the Japan Fund for Poverty Alleviation through the Asian Development Bank. The lesson learned from the programme was that technology transfer to schools from a research and development centre like SEAMEO BIOTROP, is more effective compared to direct transfer to the community. Implementation of the transferred technology to schools is more sustainable than to the community. If a model is established in a school,

operated by students and supervised by skillful teachers, the model could become the learning object of not only students but also the surrounding community, especially parents of the students.

Following the successful implementation of the School Garden Programme, SEAMEO BIOTROP also launched another programme called the Establishment of School Fruit Garden for Education, Production, Genetic Conservation, and Entrepreneurship in Agriculture Vocational School in Indonesia (SMARTS-BE) in February 2018 during its 50th-anniversary celebration. The SMARTS-BE Programme (also known as Non-Seasonal-Fruit Garden Programme) was an initiative of the former Secretary-General, Ministry of Education and Culture (MoEC) of Indonesia, Dr Didik Suhardi, who had a deep concern about the low rate of fruit consumption by Indonesians and the high amount of imported fruit found easily in Indonesian markets. He instructed SEAMEO BIOTROP to collaborate with schools, especially the Agricultural Vocational Senior High Schools to establish a non-seasonal-fruit garden in the schools' areas. The programme aimed to support the learning process, to improve the knowledge of students of fruit, and proper fruit tree cultivation in the schools. The selected schools should have enough land to produce fruits on a commercial scale, to allow students to manage fruit production commercially (maintaining quality, harvesting, grading, packaging, and marketing). Vocational Senior High Schools in Agriculture joining this programme were distributed across Indonesia up to sub-district level; therefore, the schools could be encouraged to conserve and cultivate their local fruit species and varieties. Another objective of the programme was also to develop an entrepreneurship atmosphere in the schools (production and selling of fresh fruits, processed products, and high-quality seedlings).

The SEAMEO BIOTROP's SMARTS-BE programme is part of the implementation of the Centre's programme thrust number two, i.e., Sustainable Management of Intensively Used Ecosystems/Landscapes, and the commitment of the Centre to implement priority 4 of the SEAMEO 7 priority areas, i.e., Promoting Technical and Vocational Education and Training (TVET). The Agricultural Vocational Senior High Schools could play a significant role in disseminating knowledge and mature technology on fruits trees cultivation, production, and processing to the surrounding communities and farmers. The schools could also become the hubs for technology transfer from SEAMEO BIOTROP (i.e., together with its partner universities and research centres) to the community. Once established, the school fruit gardens programme could become a demonstration or reference model for communities to learn best practices on fruit gardening at their convenient time guided by students and supervised by well-trained teachers. In the long run, the programme is expected to increase fruit production in Indonesia.

Besides the SMARTS-BE programme, SEAMEO BIOTROP has also been assigned by the Directorate of Technical and Vocational Education to train and supervise Vocational Senior High Schools in Agriculture in Indonesia to support food security and teaching factory programmes. With this programme, SEAMEO BIOTROP could transfer more expertise to the vocational schools, not only limited to fruit gardening.

This paper presents the transfer technology from SEAMEO BIOTROP, as a research and development centre, to Vocational Senior High Schools in Agriculture in Indonesia and other SEAMEO member countries. The paper also presents skill development in industry 4.0 in the area of agriculture that has been introduced to selected schools, smart agriculture technology development at SEAMEO BIOTROP that could also be transferred to the vocational schools in the future.

Fruit Tree Garden Programme (SMARTS-BE Programme)

Overall planning of the programme has been conducted by SEAMEO BIOTROP's scientist, supported by experts from IPB University in early 2018, and subsequently, a SMARTS-BE team was set up. The working area for implementing the programme was divided into six clustered areas that cover regions across Indonesia, from Sumatera in the West to Papua in the East. One coordinator was assigned to each cluster area, and they were responsible for preparing the proposal for activities in their respective regions.

There are several activities conducted in all areas, including 1) selection of target schools in each cluster; 2) setup coordination with the selected schools; 3) capacity building training for Head Masters, Teachers, and Student representatives from each school on fruit trees cultivation and fruit processing; 4) identification of the source of seeds and seedlings; 5) distribution of seeds and seedlings to schools; 6) planting; and 7) monitoring and evaluation.

Food Security and Teaching Factory Programme

A difference from the SMARTS-BE programme, is the Food Security and Teaching Factory programmes, where SEAMEO BIOTROP planned and offered training programmes that could be delivered to Vocational Senior High Schools in Agriculture. The Directorate of Technical and Vocational Education facilitated the communication between SEAMEO BIOTROP and the vocational schools. Skills that were agreed to be transferred to the vocational school teachers were tissue culture technique, production and processing of edible mushrooms, hydroponic, aquaponic, cultivation and processing of lemon, cultivation and extraction of plant essential oils, processing of essential oil to become various products, and soymilk production.

The mechanism was that vocational schools were free to choose what skills they wanted to be trained at SEAMEO BIOTROP. After attending the training for several days, the teachers would return to their respective vocational schools to implement their skills. Later, experts from SEAMEO BIOTROP visited the vocational schools to supervise and evaluate the implementation of the technology transfer. The experts helped the teachers to solve the problems so that the technology could be applied successfully.

Selection of Vocational Schools

SEAMEO BIOTROP has collaborated with the Directorate of Technical and Vocational Education of MoEC to select priority schools across Indonesia. Of the 36 schools recommended by the Directorate, only 30 schools were finally selected as target schools in 2018. Six more vocational schools were selected to join the programme in 2019, while continuously monitoring and supervising the previous group of vocational schools. Those vocational schools were chosen based on the availability of horticulture teaching activity, land for cultivation, fruit processing unit, competence teachers, the experience of the schools on fruit gardening, and school location.

The schools joining the Food Security and Teaching Factory programmes were directly selected by the Directorate of Technical and Vocational Education. There were 40 schools selected in 2018 to attend the training at SEAMEO BIOTROP. In 2019 the number was doubled to 80 vocational schools. The vocational schools came from 27 provinces in Indonesia.

Training Programme

SEAMEO BIOTROP in collaboration with the Research Centre for Orange and Sub-tropical Fruits (Balitjestro), in Batu-Malang, East Java, Indonesia had successfully conducted a training course for Head Masters, Teachers, and Students representatives from each vocational school from 31 July to 3 August 2018. This activity was officially opened by HE Prof. Dr Muhajir Effendy, MAP the former Minister of Education and Culture of Indonesia, who was also the President of the SEAMEO Council from 2017 to 2019. The training was followed by training on fruit processing in collaboration with IPB University in Bogor, West Java, Indonesia.

Training programmes on tissue culture technique, production and processing of edible mushrooms, hydroponic, aquaponic, cultivation and processing of lemon, cultivation and extraction of plant essential oils, processing of essential oil to become various products, and soy milk production have been conducted at the laboratories and units of SEAMEO BIOTROP.

Field Implementation in Indonesia

Following the completion of soil sampling and analyses obtained from the target schools, a total number of 13,500 fruit tree seedlings from various species and varieties had already been distributed to those schools and several other vocational schools nearby SEAMEO BIOTROP. With guidance from their respective SMART-BE area coordinator, teachers who had participated in the training course started to cultivate the seedlings in their school's yard. The respective coordinator for each clustered area then conducted supervision, monitoring, and evaluation by actively visiting each school to ensure the schools have planted and maintained the seedlings correctly. As part of the programme, each school was obliged to write a manual for planting a specific species of fruit trees in their field. These manuals were then compiled and documented by SEAMEO BIOTROP's SMART-BE team.

As part of the SMART-BE programme, SEAMEO BIOTROP through its tissue culture laboratory has studied the mass propagation of wild edible fruits from Indonesian forests, namely matoa (Pometia pinnata) and tropical chestnut (Castanopsis argentea). These species have been successfully propagated using the tissue culture technique. The seedlings produced through tissue culture would be distributed to the schools when ready.

To implement this SMART-BE programme, SEAMEO BIOTROP has received additional funding from the MoEC on top of its regular funding to run programmes and activities. Simultaneously, MoEC via the Directorate of Vocational Senior High School has also provided funding directly to the schools that participated in the programme. With the presence of the fruit garden as a teaching model and as a teaching factory for fruit processing and entrepreneurship classes, this programme may have significant impacts on improving teaching programmes in the schools, both for teachers and students to enhance their knowledge and skills in horticulture; particularly, in subjects related to fruit production and processing.

The SMARTS-BE programme potentially could be implemented in other SEAMEO Member countries facilitated by SEAMEO Secretariat (SEAMES), SEAMEO Centres in the respective countries, and respective government. SEAMES could assist in promoting the idea to the Ministry of Education of the SEAMEO Member Countries, while SEAMEO Centres as partners could facilitate SEAMEO BIOTROP to explore potential collaboration with relevant ministries, universities, research centres, and private companies to jointly conduct the planning, training course, implementation, and supervision of the programme.

To ensure the sustainability of the programme, SEAMEO BIOTROP will allocate a budget to maintain communication and frequent visits to the participating schools. SEAMEO BIOTROP would also promote the schools to become a reference school in the province to extend the programme to other schools and community, and also to support corporate social responsibility (CSR) programmes of nearby state and private companies.

Since the beginning, the SMARTS-BE programme has been a bridge of communication and collaboration among the participating Agricultural Vocational Senior High Schools. Communication among schools and with the SMARTS-BE team was done using a social media group. Exchange visits and knowledge sharing among schools had also been accelerated since the establishment of the programme.

Through the corporate social responsibility (CSR) programme, two schools had successfully established a link to support their SMARTS-BE programme implementation. The first one is from a state forestry company based in East Java Province, and the second one is from a gold mining company based in Papua Province, respectively. With this support, the schools could plant more fruit tree seedlings.

The vocational school teachers attending various training courses at SEAMEO BIOTROP have implemented their skills. A WhatsApp group was established to facilitate communication between participants and instructors, and also the SEAMEO BIOTROP Board of Directors. This communication platform is important to monitor the progress of the implementation of technology at schools and to help the teachers should there are any problems.

Transfer Technology to Other SEAMEO Member Countries

Technology transfer has also been conducted by SEAMEO BIOTROP to other SEAMEO member countries, especially Cambodia for hydroponic and edible mushroom production, and Brunei Darussalam for hydroponic and food processing (soy milk production, mungbean juice, and ginger sweet). While hydroponics has become a skill to teach at the university (Royal University of Phnom Penh) in Cambodia, in Brunei Darussalam it has generated entrepreneurship among students and helped the spread of hydroponic practices in the country.

Smart Monitoring

The SMARTS BE Monitoring System is the applications based spatial technology, developed and used to monitor and evaluate the SMARTS BE programme with vocational schools throughout Indonesia as members of the programme. The utilisation of geo-location information is able to represent objects comprehensively to answer rapid and accurate data needs.

The SMARTS BE Monitoring System application was developed in webgis and mobile (android) based platforms. Objectives of the SMARTS BE Monitoring System consist of building a geodatabase network between schools that are members of the SMARTS BE, implemented precision agriculture mastermind to improve the competence of educational staff in perfecting and aligning the curriculum towards the industrial revolution 4.0, and integration of fruitless agricultural crops with independent learning systems and oriented towards local fruit resources.

The architecture of the SMARTS BE Monitoring System consists of three main parts of the application, database, and connections between the two applications. Details of the architecture of the system is presented in Figure 1.

The next stage of developing the SMARTS BE Monitoring System is an expert system based on data and information that is collected from all members of the SMARTS BE, so that the SMARTS BE Monitoring System will become an integrated application and become a one-stop system in seasonless fruit development in Indonesia.

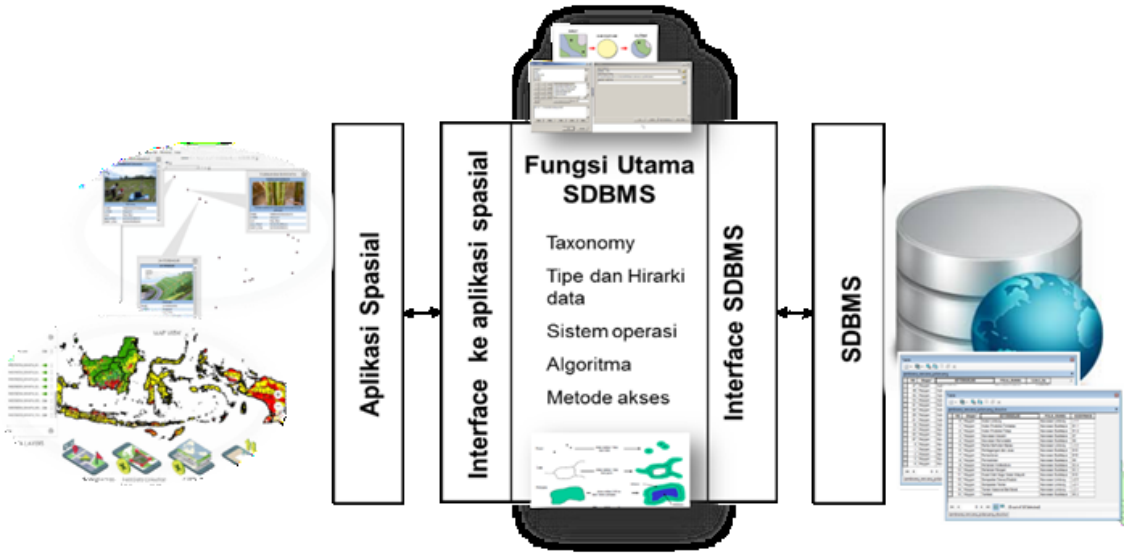

Figure 1: *The architecture of SMARTS BE Monitoring System*

Further Development of Smart Agriculture

According to the Food and Agriculture Organization (FAO), global demand for primary food (staple foods) will grow by 60% in 2050 as a result of demographic growth and changes in welfare and income levels (FAO, WFP and IFAD, 2012). This increasing global demand is confronted with the uncertainty of sufficient food supply mainly due to global climate change which also correlates with the development/change of biological enemies such as plant pests and diseases. In response to this problem, there is a need to increase agricultural production, efficiency in farming inputs, and proper use of technology and agricultural management systems that are designed towards sustainable agriculture. Hence, the adoption of information technology and mechanization in agriculture in the form of climate-smart agriculture is mandatory since it allows cultivation activities and agricultural inputs to be adequately managed following the needs of plants, soil conditions, and the environment. Smart agricultural technology combined with data-based precision agriculture will elevate more productive and resilient agriculture (Ryu, Yun, Miao, Ahn, Choi, & Kim, 2015).

Currently, the terms smart agriculture and precision agriculture have been used interchangeably (Fiehn, Schiebel, Avila, Miller, & Mickelson, 2018); (Suakanto, Engel, Hutagalung, & Angela, 2016). Precision agriculture is a combination of strategy, methodology, and technology for cultivating land with crops. The development and implementation of precision agriculture technology enable farmers to handle and manage the spatial variability

of agricultural land efficiently. It can be achieved by utilisation information and communication technology, remote sensing, geographic information systems, and navigation systems (GPS applications) that have developed rapidly to support agricultural activities (Aubert, Schroeder, & Grimaudo, 2012); (Fountas, Wulfsohn, Blackmore, Jacobsen, & Pedersen, 2006). Precision agriculture includes studies and efforts to manage spatial and temporal variability of land that can affect crop production (yields). This definition is coherent with the opinion of (Zhang, Shi, Jia, Seielstad, & Helgason, 2010) that precision agriculture focuses on efforts to regulate the amount and accuracy of input in line with land conditions and the actual needs of plants. Precision agriculture includes on-farm activities such as land management and crop cultivation, and off-farm, such as the provision of superior seeds, transportation of products, and warehousing. Precision agriculture requires that every agricultural activity, both on-farm and off-farm, is carried out correctly, in the right location, on time, in the right amount and the proper method (Gebbers & Adamchuk, 2010).

Precision agriculture is a revolution in the agriculture field that was driven by world food needs that continue to rise due to human population growth, improving the welfare and income of the people. It is also driven by the scarcity of agricultural land because it competes with the need for space for housing and human activities, which in turn triggers more studies and efforts to improve the quality of the agricultural system to be more efficient, more profitable and sustainable (Zhang, Hao, & Sun, 2017). In implementing the precision agriculture system, it requires systematic monitoring of agricultural activities and efficient techniques so that it can be done intensively to monitor any changes that occur in crops. Managing agricultural inputs through sustainable management systems such as using the right size and quantity of materials and tools/facilities, on-time handling, proper location, and methods includes processing, planting, fertilizing, pest and disease handling and fuel use, will guarantee not only the sustainability of agricultural activities but also the environment (Mulla, 2013; Gebbers & Adamchuk, 2010; Khanal, Fulton, & Shearer, 2017).

Integration of GIS Technology, Remote Sensing, and Information technology can be used to monitor agricultural activities in a landscape through spatial-temporal computing models. With this model, monitoring of the sub-unit scale of field activities can be carried out and can provide appropriate recommendations at each location depicted on the map/image. With the evolution of remote sensing, many models have been developed and used in agriculture. Several models have shown their capability to map and monitor the spatial distribution of crop yields based on spectral information and topographic characteristics, soil characteristics, and meteorological data (Kersebaum, Lorenz, Reuter, Schwarz, Wegehenkel, & Wendroth, 2005). Some other monitoring models come up with the ability to map the physiology of vegetation due to water stress (Moran, Inoue, & Barnes, 1997); (Gago, et al., 2015); (Veysi, Naseri, Hamzeh, & Bartholomeus, 2017), to map of nitrogen deficiency (Schlemmer, et al., 2013), to map of potential biomass (Machwitz, et al., 2014); (Bendig, et al., 2015), to map of pest and disease attacks (Sankaran, Mishra, Ehsani, & Davis, 2010) and to map of weed distribution within horticultural plants (Usha & Singh, 2013).

Another application of remote sensing in agriculture perspective creates a yield prediction map by using spectral formulas (Lobell, 2013) which led to further research to integrate those above-mentioned models into a spatially-explicit dynamic model which allows monitoring of agriculture using remote sensing data.

Assimilation of remote sensed data into spatially explicit dynamics model for rice yield and food sufficiency prediction

Real-time information on the status of rice production is one of the important factors in the formulation of strategic decisions by farmers (producers), the private sector, and the government. For instance, timely information and accurate estimation of the distribution and development phases of rice plants, yield potential, and harvest area are very crucial in the management of agricultural inputs such as fertilizer and irrigation, supply chain strategies, including import and export (Mosleh & Hasan, 2014; Sakamoto, Van Nguyen, Ohno, Ishitsuka, & Yokozawa, 2006; Gumma, Nelson, Thenkabail, & Singh, 2011). Besides, spatial planting lag is influenced by differences in paddy field types, geographical factors, and weather conditions. Those factors will cause variation in harvesting time and harvested area, which ultimately determines the dynamics of food supply and food sufficiency in certain districts, cities and throughout the country (Hartrisari, Imanto, & Suyamto, 2013; Sari, Ismullah, Sulasdi, & Harto, 2010).

The interaction of soil plants and the environment, including weather, is a dynamic process and may not be explained by simple regression analysis. A study (Hartrisari, Imantho, & Suyamto, 2013) had integrated remote sensed data with spatially-explicit crop dynamics model to predict harvest time and rice production by regencies in West Java (Figure 1). Another significant research output by this study was a prospect of food sufficiency per district as one critical input in determining rice import's policy and its distribution (Figure 2 and 3).

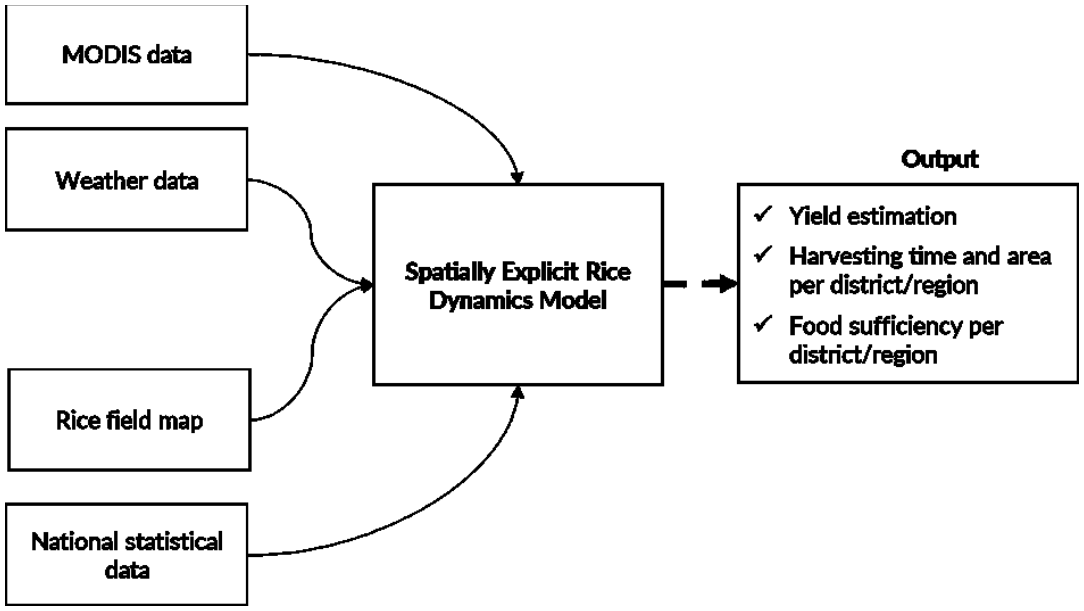

Figure 2: *A framework of integration of remote sensed data into spatially explicit rice dynamics model for prediction of harvest time and area, yield, and food sufficiency in West Java (Hartrisari, Imantho, & Suyamto, 2013)*

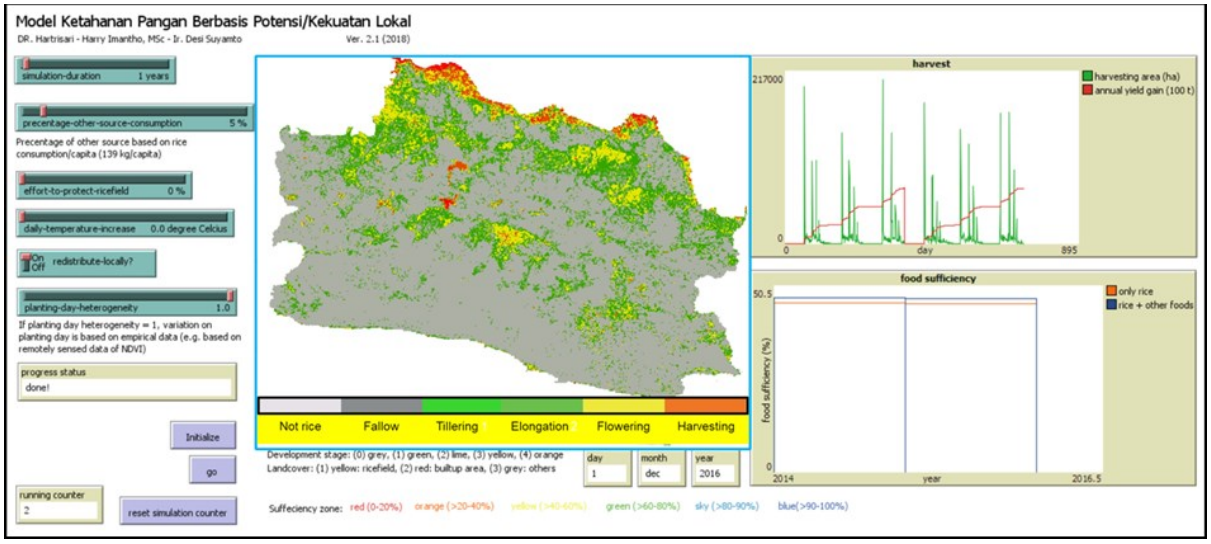

Figure 3: *Daily dynamics simulation of standing crop based on MODIS planting lag for harvest time and area, yield and food sufficiency in West Java (Hartrisari, Imantho, & Suyamto, 2013)*

Macronutrient status retrieval by using Sentinel-2 data for oil palm precision fertilizer dosage recommendation

Indonesia is the world's largest palm oil producer and exporter. According to the Central Bureau of Statistics Indonesia (BPS), in 2018, its production reaches 47.6 million tons of Crude Palm Oil (CPO), or a 12.5% increase compared to last year's production. This increase was supported by about 12.76 million ha of oil palm plantation (Indonesian Oil Palm Statistics, 2019). The production in the future is predicted to become higher because the demand for a source of fats and oil and biofuel is still growing (Comte, Colin, Whalen, Grünberger, & Caliman, 2012). However, this can lead to a limitation of available land for oil palm plantations.

Fertilizer management and application highly affect oil palm productivity. Good fertilization management benefited the plantation environment, maintain crop health, and increase yields. Good fertilization management is also a prerequisite for the sustainability of oil palm (Goh & Teo, 1998). According to Goh & Teo, 1998, one of the steps of effective fertilizer management is to assess the nutrient requirements for the growth and yield targets and prevent deficiency to occur. The common method that has been used widely to detect the nutrient in oil palm is the Kjeldahl method. Although this method is simple, it is time-consuming, destructive, and costly, especially for large area plantations (Rendana, Rahim, Lihan, Idris, & Rahman, 2015).

Several studies proved that integration of remote sensing and information technology produced many models such as crop yields monitoring model based on spectral information and topographic characteristics, soil characteristics, and meteorological data (Kersebaum, Lorenz, Reuter, Schwarz, Wegehenkel, & Wendroth, 2005), nitrogen deficiency's prediction model (Schlemmer, et al., 2013) and model for potential biomass (Machwitz, et al., 2014); (Bendig, et al., 2015). Kaliana, Seminar, Sudradjat, and Rusiawan (2019) had integrated Sentinel-2A data and nutrient empirical model to retrieve near real-time macronutrient status (Nitrogen, Phosphor, and Kalium) with satisfying results. The determination coefficient of developed models is 92% for N, 90% for P, and 85% for K. Figures 4 and 5 show the output of the spatial decision support system for oil palm precision fertilizer dosage recommendation.

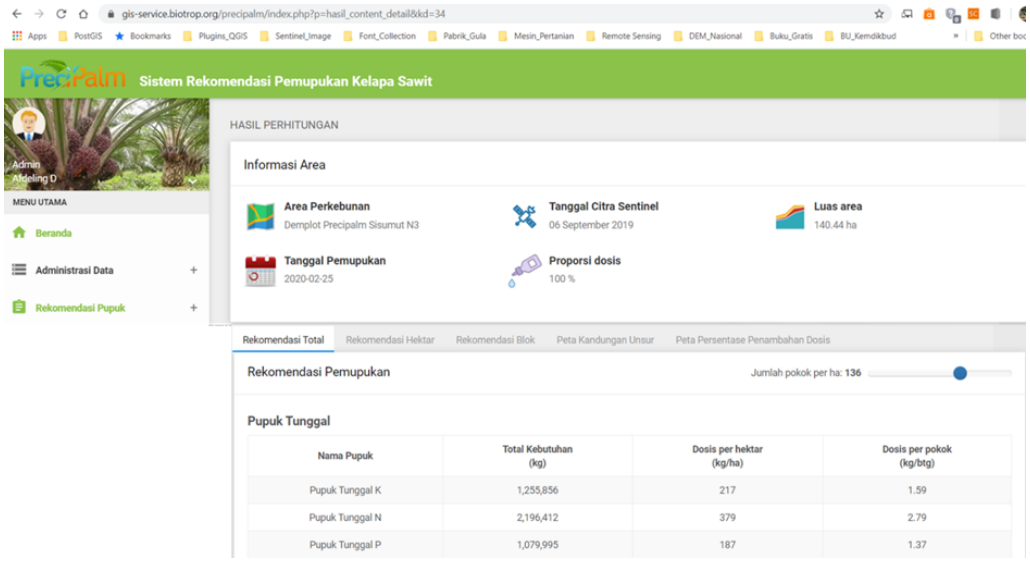

Figure 4: *Web-based spatial decision support system for oil palm precision fertilizer dosage recommendation (Kaliana, Seminar, Sudradjat, & Rusiawan, 2019)*

Figure 5: *Near real-time nutrient status retrieval as another output of a web-based spatial decision support system for oil palm precision fertilizer dosage recommendation (Kaliana, Seminar, Sudradjat, & Rusiawan, 2019).*

Potential Collaboration with Tsukuba University

SEAMEO BIOTROP could play a significant role as a technology transfer hub from universities and research centres, especially those related to agriculture. Best agricultural practices and new findings related to agriculture could be transferred from Tsukuba University to SEAMEO BIOTROP through a collaboration. The technology could then be transferred to schools in Indonesia and other SEAMEO member countries.

Conclusion

Research centres and universities are a source of innovation and new technology. However, innovation and technology would not be useful for the community until it is implemented. Research centres and universities are mostly located in the central cities away from the users of the innovation and new technology, the farmers. In the meantime, Vocational Senior High Schools in Agriculture are mostly located in areas up to sub-district level and are closer to the farms and the farmers. The students are mostly the children of the farmers living nearby the vocational schools. Hence, this would be an effective way to transfer technology to the farmers. Transfer technology from research centres and universities to vocational schools would enable upgrading agricultural practices to adopt industrial 4.0 what is also called smart agriculture.

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Education for Sustainable Development for Persons with Disabilities (PwD)

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Abstract

Technical and vocational education and training (TVET) is increasingly seen as part of a lifelong learning approach to the development of education and training system. This notion has been reiterated vastly in SDG 8 "Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all". Special Education Need (SEN) students or people with disabilities often faced challenges, discrimination, and rejection in seeking employment due to stigmatization and being underestimated in terms of capability to learn and acquire occupational skills. This article aims to explore the key elements of the TVET training programme for SEN students with a feasible connection to employment opportunities.

Keywords: Inclusive education, special educational needs, Sustainable Development Goals (SDG), TVET

Introduction

An estimated 1 billion people have some kind of disability and, in our lifetime, every one of us will probably be temporarily or permanently impaired, especially in ageing societies (WHO, 2011). This group experiences greater challenges than others in coping with transitions, lower participation in education and skills development (EC, 2010; Kett, 2012; EADSNE, 2013). The Incheon Declaration: Education 2030 (2015) also recognises education as essential to guarantee the realisation of other human rights and highlights the importance of inclusion and lifelong learning for all.

Within Sustainable Development Goal (SDG) number 4, there are specific targets regarding technical and vocational education and training (TVET). Education and training are also essential for the achievement of the other Sustainable Development Goals, including SDG 8 'Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all'. Under SDG 8, one target is 'by 2030 to achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value'. Internationally, TVET is

increasingly seen as part of a lifelong learning approach to the development of education and training system.

TVET for Special Educational Needs

TVET is steadily rising the ranks of global debates and government priorities for education and national development agendas (Marope et al., 2015). In the Southeast Asian context, SEAMEO has placed TVET as a priority agenda (SEAMEO Seven Priority Areas 2015 -2035). TVET for Special Educational Needs (SEN) students or individuals with disabilities is of major importance for sustainability and to enable these students to lead independent lives. TVET does not only prepare a person for work, but it is also a preparation for life. The purpose of TVET is to provide knowledge and skills required in the world of work and a means to support one's economic income. Therefore, it is important to make TVET accessible to all (UNESCO, 2013). To realise its potential to impact development, however, TVET systems need sustained transformation and revitalisation (UNESCO, 2012).

SEN students or people with disabilities often faced challenges, discrimination, and rejection in seeking employment due to stigmatization and being underestimated in terms of capability to learn and acquire occupational skills. Lack of inclusion in education and skills development initiatives for young people with disabilities foreshadows a lifetime of employment and marginal employment amongst a population eager to work (Putting Education to Work, 2012).

A similar situation was reported in schools where most SEN students leaving schools without being equipped with appropriate technical and vocational skills required for employment (Wehman et al., 2014). This particular group of students must be given skills that are appropriate to the local labour market. This would necessitate a change in the education system by providing skills and knowledge to students with disabilities during schooling years that can be transitioned to post-school education.

Special Education teachers play an important role in delivering an effective teaching approach to their students. Often programmes initiated by parties who do not directly engage with these students faced slow progress and challenges (Vanitha & Ramaa, 2013). The majority of vocational programmes mobilised in schools are initiatives by teachers based on their personal experience and understanding. The teaching and learning context for students with disabilities is very much dictated by the student's abilities and progress. Their source of knowledge and skills would have to be delivered by those who are trained to adopt and adapt to their learning needs.

Key Element - TVET for Special Educational Needs

The aim of this article is to explore the key elements of the TVET training programme for SEN students with a feasible connection to employment opportunities.

Figure 1 shows the three (3) fundamental elements and how they contribute to achieving the programme's overall aim, i.e. providing a successful TVET training programme and transition to employment for SEN students. The policy level, represented by the outer circle, may impact upon the factors within the elements. Recommendations for the policy level need to ensure that policies appropriately align the relevant factors so that each element makes the optimum contribution towards the TVET training programme's aim.

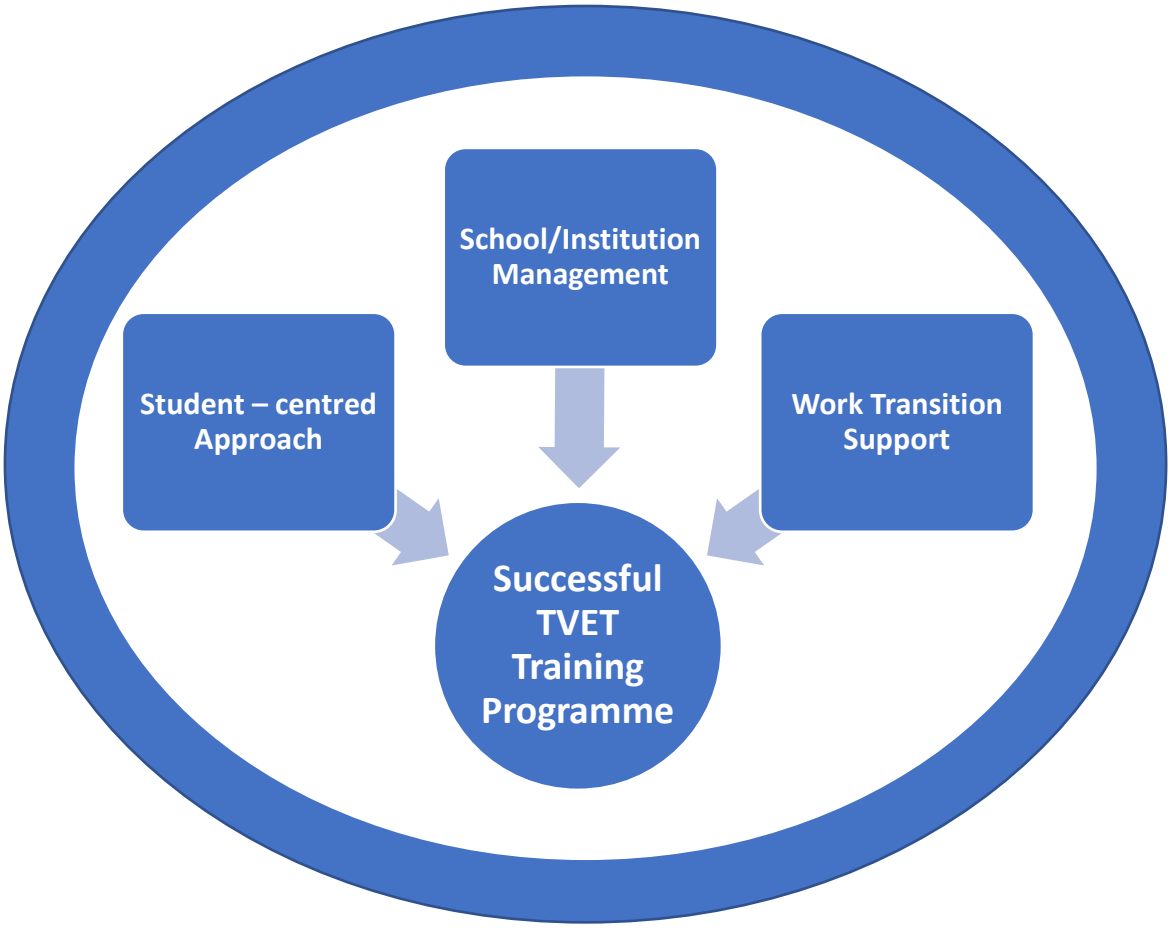

Figure 1. *Three Fundamental Elements*

School/Institution Management

School and institution management needs to develop and instil an inclusive policy, where differences among students are considered a 'normal' part of the educational culture, and to create an atmosphere of motivation and commitment. Effective school and institution management is required to look ahead and be flexible, as well as to change the structure and duration of the TVET training programme to match the students' needs. This will also include the offer for professional development opportunities to all teachers and staff, to ensure quality in education. Effective school and institution management should also able to create a flexible atmosphere to allow teachers to contribute to the development and implementation of individualised and flexible curriculum for students, to match the student's needs. This will ensure that support is provided to teachers as well as to the students during the transition phase into the labour market.

School and institution management also must move away from a traditional 'top-down' approach and should adopt a multi-disciplinary team approach with clear roles and cooperation with a high level of internal communication (peer coaching, informal discussions, collaborative problem solving, etc.) and external communication with other services.

Proper planning and focus for knowledge management for maintaining and further developing teachers' knowledge and experience must be set in place. This could involve setting up programmes or activities such as teacher training and re-training programme, seminars or conferences, sharing session on best practices or any programme that could help the teachers to be well equipped with adequate knowledge and skills to prepare their students for employment.

Student-centred Approach

Student-centred approaches concerning planning, goal setting, and curriculum design need to be used in the TVET training programme learning process, so that the curriculum, pedagogical methods, learning materials, assessment methods and goals are tailored to individual needs.

The learning process needs to use a flexible setting or atmosphere which allows for the development and implementation of a student-centred approach. Students are involved from the beginning of the individual planning process and their voices are heard throughout.

The student-centred approach requires a suitable teacher-learner ratio, a suitable support teacher-student ratio, and flexibility in the TVET training programme to allow progress from one level to another. This approach will also contribute towards maintaining a good balance between theoretical subjects and practical training, the focus on student's capabilities, and the use of hands-on/practical. The use of individual plans impacts the adaptation of pedagogical methods and techniques, on supervised practical training in companies, and on the support of students and employers during the transition phase and beyond to maintain student's employment in companies.

On the outcome side, the student-centred approach contributes to matching between work opportunities and student's expectations and also the compatibility between job skills requirements with the student's skills. This will also contribute to increasing the student's confidence that challenges can be managed and strive for a successful TVET training programme and transition in the open labour market.

Work Transition Support

To establish connections with local employers and companies, co-operative structures must be properly outlined for practical training and/or employment after graduation. Providing follow-up activities to maintain student's employment in companies require staff and resources to be permanently available throughout the transition and into work. Supporting students and employers during the transition phase in the labour market will require staff such as job coaches, career counsellors or mentors, and resources that are permanently available throughout the transition into the work period.

Adapted pedagogical methods and techniques at schools and the use of individual plans are also required. Follow-up activities can build upon connections with local employers/companies for practical training and job opportunities, the provision of supervised practical training in companies, and supported employment models that offer a gradual reduction in the intensity of support.

Follow-up activities also will contribute to the development of social skills and student's well-being, the establishment of formalised partnerships, and the re-evaluation of the correlation between job skills requirements and the student's skills.

Positive experiences of a successful work transition programme to the open labour market also contribute to and reinforce these connections and contribute to the establishment of formalised partnerships, co-operation, and networking opportunities.

Conclusion

The world is moving in a fast-changing environment that requires every individual to develop their knowledge, skills, and attitudes throughout life with education and TVET. TVET can play an important role in the development and utilisation of skills and capabilities and learning pathways, especially for persons with disabilities who are vulnerable to a lack of job security or jobs/careers for life.

There is a lot of scope for improvement in initial and continuous TVET for people with disabilities, including in apprenticeships and work-based learning. It is important to achieve the right balance between the flexibility and the standardisation of programmes and procedures. While too much flexibility can result in unpredictability and a reduction in the quality of provision, overly rigid standardisation may fail to address SEN student's needs.

TVET improvements are possible and do occur, with some key success factors being recognised across countries, and giving evidence that what is good and efficient practice for people with disabilities is, will be good practice for all learners (European Agency for Special Needs and Inclusive Education, 2013). This will require support and commitment from all relevant stakeholders and parties involved to ensure that TVET fulfils its potential contribution to Agenda 2030, including SDG 4 and SDG 8, as well as being in line with the fundamental principles of the United Nations Convention on the Rights of Persons with Disabilities (UNCRPD).

The goal of TVET education for students with disabilities is to improve their life prospects, for themselves and future generations, by becoming active members of society. Better awareness, access, and investment are essential to achieving this goal. With TVET skills, students with disabilities will be allowed to build their careers, and to develop an interest in their abilities and skills. They are able to lead a sustainable living by earning independent financial strength, contribute to society, and ultimately be empowered to live a dignified, respected, and living independently.

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Developing Human Character through SEAMEO STEM Planning and Design Learning (PaDL) Framework

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Abstract

RECSAM as the lead SEAMEO Centre pursued the development and publication of Common Core Regional Learning Standards (CCRLS) in Mathematics and Science in 2017 which presents standards for what every learner should know, be able to do, and value in mathematics and science and added support to the goal of regional integration for an ASEAN Community. The CCRLS in Mathematics and Science envisions developing basic human characters, creative human capital, and well-qualified citizens for a harmonious ASEAN society. SEAMEO RECSAM has long recognised and taken cognisance of the impact of STEM education in the national curriculum of SEAMEO Member Countries. Thus, RECSAM attempted to develop a model or framework from which STEM educators could refer as they plan and implement STEM lessons. This paper describes the STEM Planning and Design Learning (PaDL) framework which highlights the development of human empathy as one of the important stages in the Design Learning Process for students in addition to other stages of developing design ideas, prototyping/modelling, and proposing solution.

Keywords: Empathy, human character education, learning standards, STEM, values

Introduction

In this era of an automated world, the majority of countries are adopting Industrial Revolution (IR) 4.0 with the use of innovations (i.e. Internet of Things, big data, robotics, and Artificial Intelligence) to facilitate human tasks. This new culture sometimes makes people strictly depend on smart gadgets and applications that seem to turn humans into 'slaves' or merely 'followers'. Therefore, challenges faced by IR 4.0 should be balanced with Society 5.0 that asserts society should be the centre that "... balances economic advancement with the

resolution of social problems by a system that highly integrates cyberspace and physical space" (Cabinet Office, 2020). Society 5.0 originated from Japan as the country's way forward in overcoming future challenges created by IR 4.0. Nevertheless, this policy can be applicable to other countries in achieving economic development as well as in solving societal problems. One of the main concerns with rapid industrial and economic development is the eroding of the values of human character. One of the solutions is through education and apparently in STEM-related subjects. The big challenge is in developing a learning framework that would involve students to develop human character values in learning science and mathematics and STEM in general.

Human Character Overview

"Great learning and superior abilities ... will be of little value and small estimation unless virtue, honor, truth, and integrity are added to them."

- Abigail Adams (in Newell, 2013, Introduction, paragraph 5)

The above quote captures the essence and true meaning and value of human character. Character comes from the Greek kharakter to mean "engraved mark", "symbol or imprint of the soul", and "instrument for marking". The word later came to be associated with the "sum of qualities that defines a person". These qualities include a man's intellect, thoughts, ideas, motives, intentions, temperament, judgment, behaviour, imagination, perception, emotions, love, and hates. The balance of these components within the soul of each man, and the way one or another predominates over others, is what makes a character unique and sets apart one individual from another (Brett & McKay, 2020). Generally, 'character' means a distinctive mark by which one thing is distinguished from others and primarily means the assemblage of qualities that distinguish one individual from another (Homiak, 2007). Ryan and Bohlin (1999) define people of good character as individuals who know the good, love the good, and do the good. A person's 'character 'refers to the disposition and habits that determine the way that a person normally responds to desires, fears, challenges, opportunities, failures, and success (Pala, 2011).

The Importance of Character Education

"The purpose of life is not to be happy. It is to be useful, to be honorable, to be compassionate, and to have it make some difference that you have lived and lived well."

- *Ralph Waldo Emerson (in Juma, 2020, Introduction, Quote No. 6)*

The quote can be said to aptly summarise the true purpose of a life nurtured by human values and character which education for the young should cultivate in our schools.

In the US, the Character Education Partnership (2010) defines character education as the intentional effort to develop in young people core ethical and performance values that are widely affirmed across all cultures. Character education must include all stakeholders in a school community and must permeate the school climate and curriculum. Along this line, the Character Education Partnership (2010) outlines 11 principles of character education as follows: (i) the school community promotes core ethical and performance values as the foundation of good character, (ii) the school defines 'character" comprehensively to include thinking, feeling, and doing, (iii) the school uses a comprehensive, intentional, proactive approach to character development, (iv) the school creates a caring community, (v) the school provides students with opportunities for moral actions, (vi) the school offers a meaningful and challenging academic curriculum that respects all learners, develops their character, and

helps them to succeed, (vii) the school fosters students' self-motivation, (viii) the school staff is an ethical learning community that shares responsibility for character education and adheres to the same core values that guide the students, (ix) the school fosters shared leadership and long-range support of the character education initiative, (x) the school engages families and community members as partners in the character-building effort, and (xi) the school regularly assesses its culture and climate, the functioning of its staff as character educators, and the extent to which its students manifest good character.

Likewise, the Character Education Partnership (2010) listed the benefits of quality character education as follows: (i) helps students to develop important human qualities such as justice, diligence, compassion, respect, and courage, and to understand why it is important to live by them; (ii) promotes character development through the exploration of ethical issues across the curriculum; (iii) teaches how to solve conflicts fairly, creating safer schools that are freer of intimidation, fear, and violence, and are more conducive to learning; (iv) it not only cultivates minds, it nurtures hearts; (v) teaches adults and students to understand, engage in, care about, and act on core ethical values such as respect, justice, citizenship, fairness, and responsibility for self and others in school and as part of a larger community; and (vi) develops a positive and moral climate by engaging the participation of students, teachers and staff, parents, and communities.

Human Values in Mathematics and Science Education

At present, science and mathematics teachers are experiencing huge challenges with education reforms, accelerated technological advancement and globalisation which contributes to the complexities in emphasizing moral values through teaching and learning (Chowdhury, 2016).

In general, perceptions of science and mathematics are considered as cognitive dimensions and rarely seen integrated with the affective dimension. This "value-free" perception of the teaching and learning of mathematics and science is quite worrisome. If mathematics is treated as a cold hard facts and figures subject, the impact will be on students' impressions on the subject per se. This is again the irony of teachers being role models on values (Seah, 2008).

Bishop (1999) highlighted that even most mathematics teachers themselves would not consider that they are teaching any values when they teach mathematics and changing that perception may be the biggest hurdle to overcome. This situation is also supported by the research findings of Clarkson et al., (2000) in the Values and Mathematics Project (VAMP). According to Siahaan (2019), mathematics teachers did not inculcate human character values during the teaching and learning process but focused on delivering the lesson materials and on problem-solving. Nevertheless, he found that mathematics learning and character learning were taught in a separate manner. In this case, mathematics is taught directly as a subject while human character values are instilled indirectly based on the teacher's treatment of students' different ability levels. Bishop (1999) emphasized that the values in mathematics education use the deep affective qualities that education fosters through school mathematics. He stressed that values appear to survive longer in people's memories than does conceptual and procedural knowledge, which unless it is regularly used tends to fade. Despite the challenges stated, Hudha, Ekowati and Husamah (2014) claimed that students' values can be developed through learning mathematics and natural sciences because of the subjects' close relation to facts and nature.

In science education, Allchin (1998), emphasized that the common characterisation of science as value free or value neutral can be misleading. Scientists strongly disvalue fraud,

error, and 'pseudoscience' but value reliability, testability, accuracy, precision, generality, simplicity of concepts and heuristic power. He expounds that values intersect with science in three ways, namely; (i) there are values, particularly epistemic values, which guide scientific research itself, (ii) because the scientific enterprise is always embedded in some particular culture, values enter science through its individual practitioners, whether consciously or not, and (iii) values emerge from science, both as a product and process, and can be redistributed more broadly in the culture or society.

According to Allchin (1998), to cultivate the teaching of ethics and values, science education must be viewed as including the process and context of science and not merely its content. The values which guide scientific inquiry perhaps can best be introduced in a constructivist setting where the teaching is not centred on specific content but rather on engaging students in exploring values, ethical reasoning and demonstrating a process for discussing them collectively. The students have engaged in the modest scientific activity themselves like asking them to reflect on their own process, on their standards of proof, or on the role of multiple investigators for instance of fraud, letting them articulate and illustrate accepted values, allowing them to question and discuss any scientific claim. An important goal is for students to learn ethics, and discussion of public values require justification as much as any scientific argument does. Therefore, lessons need to be designed at a level appropriate to the students' ages or educational maturity.

Development of Human Character in the SEAMEO Basic Education Standards (SEA-BES) Common Core Regional Learning Standards (CCRLS) Frameworks for Mathematics and Science

SEAMEO education priority areas include development and enhancement of 21st century skills comprising of character education, entrepreneurship education, information and communications technology, language and literacy, numeracy, and scientific and technological literacy in all learners. Along this line, SEAMEO RECSAM led the project initiative SEAMEO Basic Education Standards (SEA-BES) which developed the Common Core Regional Learning Standards (CCRLS) in Mathematics and Science and was successfully published in 2017. The SEA-BES project is re-aligned into Priority Area #7 "Adopting a 21st Century Curriculum" which states "to pursue a radical reform through systematic analysis of knowledge, skills, and values needed to effectively respond to changing global contexts, particularly to the ever-increasing complexity of the Southeast Asian economic, socio-cultural and political environment, developing teacher imbued with ASEAN ideals in building ASEAN Community within 20 years" (SEAMEO, 2018).

Mathematical Values, Attitude and Habits of Human Character in CCRLS in Mathematics

The mathematical values, attitudes, and habits for the human character development of the framework for CCRLS in Mathematics together with mathematical thinking and processes, and contents are shown in Figure 1.

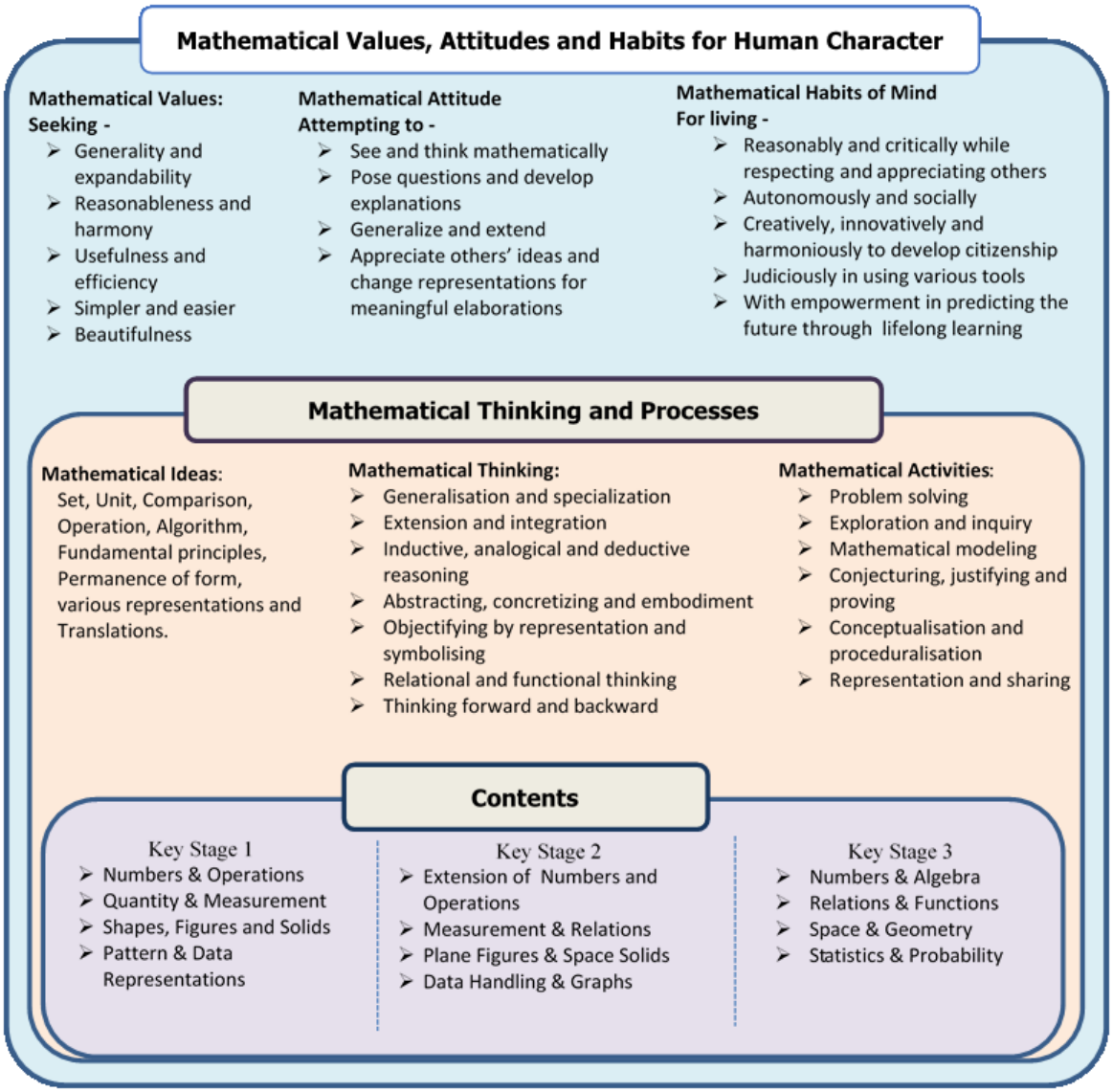

Figure 1: *CCRLS Framework for Mathematics.*

The aims of Mathematics in CCRLS are to (a) develop mathematical values, attitudes and habits of mind for the human character, (b) develop mathematical thinking and enable to produce appropriate process, and (c) acquire proficiency in mathematics content and apply mathematics in appropriate situations. Eventually, the aims would lead to the development of basic human characters, creative capital, and well-qualified citizens in Southeast Asia for a harmonious society through mathematics (Mangao, Ahmad, & Isoda, 2017).

Ethics, Values and Attitudes in CCRLS in Science

The components of the framework of CCRLS in Science are shown in Table 1 comprising of ethics, values and attitudes; scientific skills, processes and thinking; and content.

Table 1. *Components of CCRLS Science Framework*

Content	Scientific Skills, Processes and Thinking	Values and Attitudes
• Scientific Inquiry • Life and the Living World • Material World • Energy and Change • Earth and Space • Science, Engineering, and Technology for Sustainable Society	Science Skills and Process • Questioning • Observing • Classifying • Measuring • Hypothesizing • Predicting • Inferring • Explaining • Communicating • Evaluating • Identifying and controlling variables • Formulating and testing hypothesis • Defining operationally • Interpreting data • Planning and carrying investigations Thinking • critical and creative thinking • reasoning • problem solving • decision making • applying and creating • generating solutions • safe use of equipment • ICT skills • Collaboration skills	• Caring for the living and non-living environment • Social awareness • Sustainability • Responsibility • Truth • Interdependence • Integrity • Perseverance • Self-discipline • Self-esteem • Empathy • Appreciation • Trust • Critical reflection • Inventiveness • Tolerance • Uncertainty • Belief and interest • Curiosity • Honesty • Objectivity • Open-mindedness • Respect for evidence

Among the aims of the CCRLS in Science include demonstrate ethical behaviour, scientific attitudes and values when undertaking scientific thinking and processes, and demonstrate the ability to use the acquired scientific thinking and processes in making an informed decision, and debating scientific and social-cultural issues.

Empathy in STEM Education

Merriam-Webster Dictionary defines empathy as "the action of understanding, being aware of, being sensitive to, and vicariously experiencing the feelings, thoughts, and experience of another of either the past or present without having the feelings, thoughts, and experience fully communicated in an objectively explicit manner." By understanding others' feelings, one can respond aptly to the situation. This human character value is important in determining the decisions made based on many aspects of life situations.

Scientists and engineers are often perceived as lacking interpersonal skills, and these beliefs can alienate particular students from engaging in or identifying with STEM-related fields. Cheryan et al. (2013) investigated stereotypes in the science field among US undergraduates towards computer science and gender differences. They pointed out the perception that computer scientists are technology-oriented, with strong interests in programming and electronics (Cheryan et al., 2011b), and little interest in people (Diekman et al., 2010). These undergraduates perceived that computer scientists are less likely to work with and help others compared to those other careers, such as medicine and law. The perception that computer science is technology-oriented rather than people-oriented may cause women to express less interest in the field than men (Diekman et al., 2010). Engaging students in empathy can make STEM learning more meaningful because students can see the impact of STEM in their lives and the lives of others. By making STEM content relevant, students will be able to see themselves as potential contributing members of the STEM community. Taking a more interpersonal and empathy-based approach to STEM learning can also broaden our visions of what it means to be a "STEM person". Such work aligns with research that emphasizes the need for teachers to make instruction culturally relevant and accessible to all students (Ladson-Billings, 1995).

Empathy in SEAMEO STEM Planning and Design Learning (PaDL) Framework

SEAMEO RECSAM and Faculty of Education, Monash University are currently undertaking the development of curriculum design called the "STEM Planning and Design Learning Framework to illustrate the workings of STEM as a pedagogical approach. The PaDL framework is comprised of Design Planning Model for Teachers and Design Learning Process for Students (Mangao, Kidman, Tan, Gesthuizen, & Mcdonald 2019). The STEM PaDL Framework was developed from the analysis of 14 commonly used Western planning models and learning designs combined with the experiences, knowledge and skills, and values of the ASEAN educators who attended the workshop. Among the teacher planning models reviewed and compared were: Teaching with technology; TPACK model; Polya's problem solving; Conceptual model for teaching arithmetic problem solving; Team initiated problem solving slide 5; Conceptual framework of the math problem-solving process; Science and Engineering practices; Science in Early Childhood Classrooms: Content and Process; The difference between Science and Engineering; and Writing Lab reports: Overview. For the Design Learning Process for Students, models reviewed and compared included: NGSS Engineering Design Process; What is design thinking; Design Cycle; and Getting to grips with Design Thinking.

Integrating Human Character of Empathy into the Design Learning Process for Students

The Design Learning Process for Students model is a particular pedagogical approach that will develop students' collaborative, problem solving, and 21st Century skills while learning and applying their disciplinary knowledge and skills. Figure 2 shows the four main stages of this model, namely, (1) empathising, (2) developing ideas, (3) prototyping/modelling, and (4) proposing a solution.

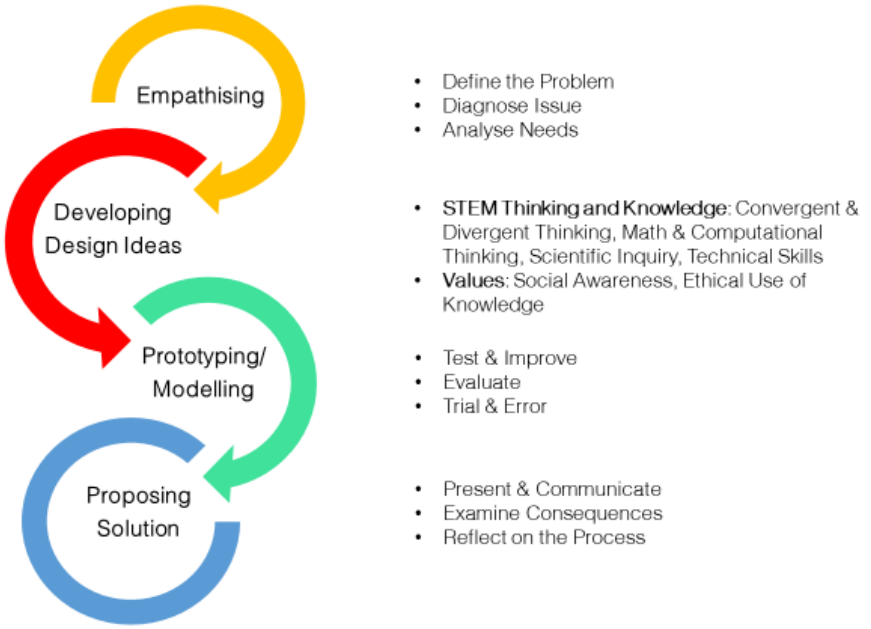

Figure 2. *The Design Learning process for students*

The Empathising Stage

The empathy stage is the first stage of developing a human-centred view of problem solving. This human-centred approach ensures that the design and the proposed solution are anchored in the real-world. Students observe other people, examine their context, and listen to their needs and requirements. Students become more deeply empathic and understanding. It will help the students make the right decisions and avoid design failure when solving problems. A lack of empathy will contribute to design failure. Humans and communities have various degrees of willingness to adopt particular solutions to problems, which can act as potential design constraints. Engaging in empathy encourages students to examine these constraints from multiple perspectives and to ask questions to refine ideas and solutions to better address these constraints.

Empathising to Developing Design Ideas

In this stage, students brainstorm many different ideas, based on the problem, issues and needs found in the previous stage. Students use their social awareness and ethical use of knowledge. Students combine their understanding and knowledge in different subjects (i.e. Mathematics, Science, and Technology) to new thinking about how to solve the problem or issue. Students think creatively and generate the widest possible range of ideas from which they can choose. Students use their conscious and unconscious mind, logical thinking, computational thinking, and imagination.

Developing Ideas for Prototyping/Modelling

From the previous stage, students narrow down their options to find the best solution through testing prototypes or models. In this stage, students design and construct a unique model that solves a real-world problem. The students clearly illustrate what the model could look like, how it works, or how it could be used. The model could represent the behaviour of a solution, or test the solution in different ways. It is something that students can showcase, learn about, share, and build from. The modelling process rapidly moves from an initial paper design towards a working solution, physical 3D model, or prototype, with idea checking along

the way. Moving from idea generation to hands-on action and construction requires mental activity that constructs new knowledge and objects. Students must collaborate in groups and draw plans, communicate with others to explore alternative ideas, and build new knowledge.

Prototyping/Modelling to Proposing Solution

In this stage, students get feedback, evaluate their prototype or model, consider the consequences, and come up with the groups 'solution to solve the problem. Students finalise their prototype or model into a model that is realistic and as good as possible given the time frame and resources. They also decide how to present their solution to the audience, to convince them that their solution is the best possible. Students use words, diagrams, graphs, and other media to present their solutions to convince others. Students refer back to the context or problem to check if their model or prototype is the best solution, then reflect on the entire design process and make improvements.

Iteration and making the process your own

This process can go in many cycles and sometimes teachers have to go back to the previous stage or even back to the first stage, in order to go forward. This process is only a suggestion and, in the end, teachers have to make the process their own and adapt it to their style and your work. It is about the teacher's way of thinking and working.

Conclusion

In conclusion, since Education 4.0 is introduced to align with the progress in IR 4.0, now education has to keep up with achieving Society 5.0. Ideally, there should be a balance of technology and saving human values as a human who created the technology naturally would realise that human values help society and the world work in harmony. Aligning with the rapid changes in the industry, education should be the frontrunner in making the changes to suit Society 5.0, in this particular case within the aspects of teaching mathematics and science or in STEM education. Therefore, a comprehensive framework for teaching STEM incorporating the human character should be developed to assist teachers and educators alike in inculcating the human character such as empathy (in this case) in teaching and learning. According to Sun (2017), engaging sympathy in students makes STEM lessons more meaningful because it affects them and their surroundings. Furthermore, producing students with empathy will create a mature generation with the ability to resolve issues with practical solutions for various conditions. Hence, in achieving Society 5.0, this human-centred society also contributes to the attainment of Sustainable Development Goal #4 Quality Education (SDG#4) established by the United Nations.

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The Challenge of ECCE Inclusive Education for Society 5.0 in Southeast Asia

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Abstract

Progressions in digital technologies as well as in their uses continuously happen in the realm of Industrial Revolution 4.0 affecting all facets of human's life, including education. This article aims to answer the questions on how do we truly include and benefit everyone equally around the world. It answers how does the Southeast Asian Ministers of Education Organization Regional Centre for Early Childhood Care and Parenting (SEAMEO CECCEP) promote education systems to drive inclusive growth and prepare us for Society 5.0 in the area of ECCE and parenting in order to meet the SEAMEO's Seven Priorities Education Agenda 2035 aligned with the UN Sustainable Development Goals (SDG). It calls for educational reforms for well-balanced regional development.

Keywords: Early childhood education, inclusive education, parenting, social inclusion

Introduction

A commitment to improving and sustaining the quality of early childhood care and education (ECCE) has reached global prominence as seen in the actions of many international organisations during the past fifteen years (Cochran, 2011). Progress for Children Beyond Averages: Learning from the MDGs (11th edition), published in June 2015 by UNICEF, presents the latest data showing that tremendous advances in the lives of the world's children which have been driven by the Millennium Development Goals. It is clear, however, that development efforts in the past fifteen years have failed to reach millions of the most disadvantaged (UNICEF, 2015, p. iii). ECCE plays a significant role in childhood development. ECCE has consequences for children's development. Children who attend ECCE perform better in mathematics, literacy, and social skills in the future. ECCE also plays vital and important roles in a country's development. In fact, ECCE has become a global concern as it is reflected in SDG 4: Quality of Education.

The roadmap of SDG Target 4.2 ECCE clearly stated that by 2030, that girls and boys have access to quality early childhood development, care, and pre-primary education so that they are ready for primary education. The foundation of the roadmap is the commitment of regional

leaders. The roadmap started in 2016 by implementing socialisation as Phase 1. In 2020, Phase 2 is about the implementation of best practices all over the globe. Phase 3 will start in 2025 by disseminating best practices all around the world. The achievement of child development is then being examined and analysed. By 2030, Phase 4 will evaluate the whole process with the hope that the target is well achieved.

The Importance of ECCE

The research of Nobel Prize-winning Economics Professor James Heckman (2008) of the University of Chicago on investing in early childhood development (ECD), demonstrated that the quality of early childhood development (ECD) heavily influences health, economic and social outcomes for individuals and the society at large. In short: investing in ECD produces enormous economic gains. According to Heckman, ECD has even a higher rate of return per dollar invested than interventions directed at older children and adults.

Heckman believes that by preventing the achievement gap, improving health outcomes, boosting earnings, and providing a high rate of economic return will become the benefits of investing in quality early childhood education for disadvantaged children. Thus, prioritising to invest in ECD sector to have a better generation in the future is a better choice that countries need to consider.

The Social Inclusion in ECCE Context Within Society 5.0

The target SDGs 4.2 is one of the examples of a definition of inclusion by providing equal access to boys and girls. It is expected that education will address all children around the globe. Referring to the report from World Bank, inclusion means the process of improving the terms for individuals and groups to take part in society and the process of improving the ability, opportunity, and dignity of people, disadvantaged based on their identity, to take part in society. Within the equity principle, educators do not attempt to treat all children equally, but instead, they would ensure that every child will receive different support that would enable them to have equal access and opportunity to ECCE

We need to discuss social equity in ECCE as education is a tool to dismantle all forms of racism, prejudice, and hegemonic thought and behaviour (Robinson & Díaz, 2006; Earick, 2009; Daniel & Escayg, 2019; Hall, 2019). Furthermore, The United Nations Convention on the Rights of the Child states the aim of educators should be to prepare 'the child for responsible life in a free society, in the spirit of understanding, peace, tolerance, equality of sexes, and friendship among all peoples, ethnic, national and religious groups and persons of indigenous origin' (Save the Children 1997, Article 29. 1d, 109).

The nature of Society 5.0 as a "super-smart society" was preceded by the hunter-gatherer society (Society 1.0), the agricultural society (Society 2.0), the industrialised society (Society 3.0), and the information society (Society 4.0). It is a human-centred society that balances economic advancement with the resolution of social problems by a system that is highly integrated cyberspace and physical space. It envisions a sustainable, inclusive socio-economic system, powered by digital technologies such as big data analytics, AI (Artificial Intelligence), the Internet of Things, and Robotics. The Japanese government in 2016 proposed "Society 5.0" in the 5th Science and Technology Basic Plan in 2016 (a five-year national strategy formulated by the Council for Science, Technology, and Innovation).

Society 5.0 achieves a high degree of convergence between cyberspace (virtual space) and physical space (real space). In the past information society (Society 4.0), people would access a cloud service (databases) in cyberspace via the Internet and search for, retrieve, and analyse information or data. In Society 5.0, a huge amount of information from sensors in physical space is accumulated in cyberspace. In cyberspace, big data are analysed by artificial intelligence (AI), and the analysis results are fed back to humans in physical space in various forms.

In the past information society, the common practice was to collect information via the network and have it analysed by humans. In Society 5.0, however, people, things, and systems are all connected in cyberspace and optimal results obtained by AI exceeding the capabilities of humans are fed back to physical space. This process brings new value to industry and society in ways not previously possible.

In the information society (Society 4.0), cross-sectional sharing of knowledge and information was not enough, and cooperation was difficult. Also, due to various restrictions on issues such as a decreasing birthrate and aging population, and local depopulation, it was difficult to respond adequately. There are platforms businesses, such as Windows, Amazon, Facebook, Apple, even the huge receipt site like Cookpad. The platform is provided where information, products, and other services are made available, and due to its network effect, it can provide services and functions far beyond those that only one company could provide. Not to mention, the vast growth of the Internet of Things (IoT) which means connecting things other than computers and mobile phones to the internet. For the reason that there is a limitation to what people can do, the task of finding the necessary information from overflowing information and analysing it was a burden, and the labour and scope of action were restricted due to age and varying degrees of ability. In society up to now, a priority has generally been placed on social, economic, and organisational systems with the result that gaps have arisen in products and services that individuals receive based on individual abilities and other reasons.

In contrast, Society 5.0 achieves advanced convergence between cyberspace and physical space, enabling AI-based on big data and robots to perform or support as an agent the work and adjustments that humans have done up to now. This frees humans from everyday cumbersome work and tasks that they are not particularly good at, and through the creation of new value, it enables the provision of only those products and services that are needed by the people at the time they are needed, thereby optimising the entire social and organisational system.

The Challenge of ECCE Inclusive Education for Society 5.0 in Southeast Asia

Some concerns emerged within the idea of Society 5.0, i.e. the ways we live and work, and the meanings of work are changed drastically. The environment surrounding young children will also change a great deal. Furthermore, it is important to create a human-centred society. Young children will be exposed more to virtual experiences with an increased reality. Moreover, it is important to create a human-centred society, where every single member will lead a happy and affluent life.

Another challenge is the forms of learning that will be transformed in the new society. This will be in line with the challenges of ECCE teachers in Southeast Asia at present. Firstly, the high disparity of ECE services between urban and rural areas and secondly, that most villages in some countries do not have an ECE Centre, especially those located in underprivileged,

outer-front, and outer-most areas. Thirdly, there is an urgent need for quality ECE teachers, and finally there are insufficient policy and learning frameworks.

Making sure that all children have the equal access to the ECE services is one of the examples of how a government can address the disparity issues of ECE between urban and rural areas. Urban areas are most likely to have a good facility for children to access. On top of that, the quality of ECE services is another challenge that developing countries need to tackle. The quality disparity of ECE services between rural and urban areas is also one problem that perhaps is a vicious cycle with the quality of ECE teachers. In many developing countries, it is obvious that ECE teachers are still the underdeveloped human resource.

Roles and Key Functions of SEAMEO CECCEP to Deal with Inclusive Education

SEAMEO CECCEP as an organisation within Southeast Asian countries has the mandate to be a centre of excellence in research, capacity building, and advocacy and partnerships in ECCE and parenting. It also tries to cope with problems of inclusive education, especially in ECCE.

SEAMEO CECCEP takes the part of becoming a research-hub that collects and analyses data and disseminates information and expertise related to ECCE and parenting within the SEAMEO Member Countries by, first, expanding access to a quality ECCE by implementing the result of reports of regional documentation of Innovative Financing Mechanisms and Partnerships on ECCE. Thus, SEAMEO CECCEP has undergone several research projects to address issues of access and quality of ECCE services. Regional documentation of innovative financing mechanisms and partnerships for ECCE in Asia Pacific is one of the examples of the study that it collaborates with UNESCO Bangkok. Another pilot study that has been conducted as a collaboration study with UNESCO Paris is a survey study of teachers in pre-primary education.

Second, providing quality ECCE means better teacher performances. UNESCO Bangkok and SEAMEO has a guide on ECCE Teacher's Competency Framework (TCF). Making sure that TCF has been implemented in Southeast Asia is one factor that is improving quality of ECCE teachers. SEAMEO CECCEP tries to reach many stakeholders of ECCE in Southeast Asia to promote the programme to elevate access and quality of ECCE services in the region. By signing a memorandum of understanding with partners such as a university, district and any other relevant partners, SEAMEO CECCEP would like to ensure that there will be better services in the future.

Third, it equips teachers with understanding, knowledge, and practices of inclusive education through training, courses on inclusive education in partnerships with other SEAMEO Centre or other organisations. SEAMEO CECCEP has conducted several trainings for ECCE teachers in the region. Specifically, the Centre has conducted training in Cambodia, Timor Leste, Vietnam as well as Indonesia to build a good understanding in ECCE teaching and learning practices. SEAMEO CECCEP in collaboration with university partners has create many modules for teachers in many relevant fields of ECCE.

Way Forwards and Suggestion Concerning Inclusive Education Related to SDGs 4.2

There is an endeavour of improving access and quality of girls' education through community-based early childhood education and early-year gender mainstreaming, through:

1. Supporting girls to transition from early childhood education to lower primary education;

2. Supporting the creation of a gender-responsive and safe teaching-learning environment, free of school-related gender-biased violence;

3. Engaging female and male teachers to develop gender-responsive teaching attitudes and practices and be change agents; and

4. Increasing parents, teachers, and governments' (national and local) understanding and commitment in realising gender equality and equity as well as implementing gender mainstreaming education in early years.

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Barriers to Inclusive Education: A Critical Analysis of Implication of Village Education Development Committee (VEDCs)'s Participation toward the Border School Development Project

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Abstract

This research aims to (1) investigate the level of understanding of Village Education Development Committee (VEDC) of their roles; (2) determine the effectiveness of VEDCs' participation in their community and school development; and (3) identify the main obstacle faced by VEDCs and measures taken to overcome the challenges in Border Schools of four provinces where the school has a Border with Thailand, Vietnam, Myanmar, or Cambodia. The qualitative method was used for data collection through a focus group discussion with 28 VEDC members, semi-structured interviews with 16 members of VEDC, and interviews with 14 participants from various stakeholders at the fieldwork. The findings showed that VEDCs are playing some roles in most aspects of the School Development Programme (SDP), especially in rural and remote areas. The VEDCs seem to be active in problem analysis, identifying priority needs and simple strategies to address the needs of the communities. However, there are also challenges in ensuring that all members are committed to and capacitated for their roles. This study recommends that SEAMEO CED should work closely with VEDCs and motivate them to be more effective in supporting student's enrolment, improving infrastructure, and making various kinds of contributions to school development.

Keywords: Border school, community development, village education development, inclusive education

Introduction

Education Law of Lao PDR with reference no. 62/16.07.2015. Article 3 of the Education Law demonstrated that Village Education Development Committee (VEDC) is one organisation under the umbrella of the Ministry of Education and Sports which has responsibility for supporting formal and non-formal education learners and encourages all people could access education. VEDCs members involved a person who is coming from a diverse relevant organisation. To support the decentralisation process, on 3 September 2008, Ref. No. 2300/MOES.DP.08, Ministerial policy made provision for the establishment of Village Education Development Committees (VEDCs) to help community people, formal, non-formal, and informal education leaners. Building on existing work on VEDCs supporting in school development, it identifies the opportunities and barriers that VEDCs are facing and reflected in rural Education Development Programme (Lao People's Democratic Republic, 2015).

The VEDC seeks to promote a better understanding of education development issues in all provinces among planners, policymakers, academics, and researchers. As education continues to face increasingly complex challenges of education development, the knowledge base required to inform policy choices has become increasingly important. The VEDC programme was planned to help promote a more effective link between members and application of their roles effectively. VEDCs aims to engage the policy process by supporting scholarly works that would bring multifaceted perspectives on development issues and provide new knowledge on the impacts and consequences of policy choices. By providing resources and opportunities, VEDC could be a potent and active partner in the education development process. To benefit from the opportunities provided by the model of VEDC, the Government of the Lao PDR needs to seek best practices of VEDC roles, good outcomes of communities, and ensure that all poor household, minorities ethnic group could access basic education at least in pilot areas of SEAMEO CED Border Schools Project.

Research Question, Objectives and Methods

The main research question of this study is: What are the key challenges for VEDC of their contribution to improving teaching, the learning environment and linking home and school cultures?

Based on the key research question above, the objectives of this research are to:

1) Critically analyse VEDC's participation in the management of communities, VEDCs and their contribution towards achieving the Education Quality Standards (EQS) at the school level;
2) Assess the level of diversity within the VEDC representative structure, with a particular emphasis on the inclusion of women and mariginalised groups especially in Border Schools Project;
3) Assess the efficiency and sustainability of VEDC capacity-building approaches currently being implemented in the country; and
4) Generate lessons and provide recommendations to inform and support the revision of existing VEDC guidelines and the design of upcoming programmes under the Border Schools Project umbrella that will work in the area of school-community partnerships/ VEDCs and school-based management.

Methods

Common qualitative methods such as interview, field work and focus group discussion (Denzin & Lincoln, 1994) were used to collect the data through VEDCs' formal and informal meetings. A literature review of the VEDC relationship between communities, school instructors, and education development stakeholders was done to provide a solid background for the study. The study also conducted field work that includes three focus group discussions with 25 VEDC members, semi-structured interviews with 12 members of the Village Educational Development Committee as well as 14 participants from various stakeholders at the local, district, and national level. The data of each Province and Village have been collected with the Department of Tourism and Culture and from the Chief of Villages in 2019.

SEAMEO CED partnership with VEDCs

SEAMEO CED cooperates with VEDCs to find ways to promote equitable access to education for the poor and disadvantaged children at the school level through several programmes, projects, activities, events, etc. Then, encourage, promote, motivate, provide assistance, and organise various training workshops, meetings with the management levels and the communities in order to improve the quality of education through the improvement of the existing curriculum, new textbook writing, printing textbooks, and nationwide distribution, train teachers and school managers. Furthermore, the education leaders in four provinces where schools are located in borders with SEAMEO Member Countries acknowledge themselves that they have a commitment with SEAMEO CED to develop school and communities in certain areas following the mission and vision of SEAMEO CED. Currently, CED plans to collaborate with other SEAMEO Centres for the:

- Provision of usable water supply (drinking and washing water): a pipeline from mountains, pneumatic water sources, wells, etc.;
- Electricity connection where possible;
- Provision of teachers and teaching-learning equipment/ materials;
- Provision of training for VEDCs on how to collect data effectively by using the collecting data programme, and
- Provision of training of leadership, management skills and technical how to deal with community's people and so on.

Even though the government provides several programmes of training and the terminology is widely recognised, yet VEDCs in the Border Schools Project have few chances to access it because geographically they are isolated with no roads, no electricity, and so on to permit access. The SEAMEO Secretariat raised the awareness of the barrier to inclusiveness of the borderland people which was led by SEAMEO CED in partnership with other SEAMEO Centres to explore challenges faced by the school, people in the border areas and identify in SEAMEO Centres and partners the examples of good practices for providing an inclusive education for marginalised learners.

What should VEDCs do in the Border Schools Project?

SEAMEO CED has several missions for the VEDC to help and work effectively at the SEAMEO CED Border Schools Project. VEDCs in larger or multi-ethnic villages are often not availing themselves of the existing provision to extend beyond seven members. The 'status-based' VEDC structure promotes its authoritative agency but not necessarily its inclusivity or continuity. There are also challenges in ensuring that all members are committed to and capacitated for their roles. Most VEDCs meet fairly regularly, but not on the monthly basis recommended in official guidance.

The Three-Year Border Schools Project led by CED has never stopped to find partners who have the same or similar target to help the community and students in rural remote areas. Currently, SEAMEO CED has developed partnership with the regional centre of DVV International and collaborated with SEAMEO INNOTECH to support VEDC and Community Learning Centre (CLC) members' roles to effectively be applied in their communities and help the community to eradicate poverty as well as disseminate the best result of their development performance models to more villages in Border Schools.

Below is the agreement and support to top-down policies for the VEDC Mission of SEAMEO CED Border Schools Project.

The role of VEDCs is to:

- Summarise and study data concerning the various problems of teachers, students, illiterate persons, schools, equipment and learning/teaching materials.
- Create village education development plans; based on the ideas and needs of the villagers.
- Set up procedures for the labour involved in the construction and maintenance of the school and the school environment and monitor construction, repair and maintenance work.
- Facilitate the wider community in - school construction, repairs and maintenance - allocation and improvement of classrooms and the school environment - looking after the lives and wellbeing of the teachers. (Seel, I'Anson, & Lomathmanyvong, 2015).

Moreover, VEDC plays a major role in bringing the positive attitudinal change in people towards education and in mobilising the community and motivating parents/ guardians to send their children to schools, especially girls and children from disadvantaged groups. They are also responsible for school construction and maintenance, purchase of materials, school mapping and micro-planning exercise, preparation of Village Education Plan and school management as well as teacher performance. The village education committee performs activities regarding management and maintenance of the schools and is particularly useful in monitoring and supervision of primary schools (MoES, 2013).

VEDCs' Support to Equitable Access and Inclusion

In support of equitable access and inclusion, the VEDCs roles are to:

- Collect data on the total number of households and poor households.
- Collect data on school-aged children (and illiterate adults), specific situations, etc., disaggregated by gender and ethnicity.
- Promote education for children and adults who have never yet studied, or who dropped out from studying regularly, especially females and members of ethnic groups.

- Advise on food that is healthy according to the nutritional principles.
- Monitor the attendance of children, especially with respect to absenteeism, so as to consult their parents or guardians in order to find a solution.
- Promote the vocational skills of the community and young people by promoting traditional arts and handicrafts and the establishment of income generation groups.

The wider community should:

- Collect statistics on school-aged children in the village, assist poor children, send their children to school regularly, check the number of students with class teachers, watch out for children not going to school (Seel, I'Anson, & Lomathmanyvong, 2015).

A key function of the VEDC is to support and encourage access to education and to reduce the dropout of children from school. A central strategy that is stipulated in the collection of disaggregated data on household membership, which has the potential not only to increase enrolment but also reduce inequalities related to gender, poverty, remote location, or other factors. Frequent interactions with the community including visits to children's homes are also encouraged.

VEDCs' Support for Teaching/ Quality

Roles of VEDCs to support quality teaching are to:

- Create lists of qualified and unqualified teachers, persons able to assist teachers and school principals, and teachers' needs.
- Take the various issues involved with learning and teaching for consultation with the villagers, teachers, and students so that they may together seek out solutions according to actual circumstances and the capacity of the village without having to rely on superior levels.
- Organise activities for students to improve and repair the school, to purchase learning and teaching equipment, and to assist teachers when in difficulty.
- Set up storytelling and the telling of local fables and legends (potentials/heritage) and the cultural, material, and psychological ways [of their village] by village elders, teachers, and educated persons of the village families.

Areas for wider community participation for monitoring and assisting teachers in their teaching:

- Monitor the punctuality of teachers with respect to their teaching hours, check whether or not the days off taken by teachers are in accordance with the officially issued calendar.
- For those with knowledge or expertise in a field that is suitable for the subject or lesson being taught, assist the teachers (especially in the teaching of local curricula).
- Assist teachers in the production of teaching equipment and so forth (Seel, I'Anson, & Lomathmanyvong, 2015).

Strategies to Improve Teaching and Learning

The following are the strategies to improve teaching and learning:

- Encouraging children's regular attendance,
- Monitoring teacher attendance,

- Food and accommodation support for teachers,
- Provision of materials for teaching-learning resources,
- Extra-curricular activities for children, and
- Encouraging different contributions from the community to improve the learning environment.

VEDC has received insufficient investment to effectively fulfil its mandated roles. The report on Basic Education notes that 'the effectiveness of VEDCs seems to rest on a range of factors, including the capacity and education levels of its members, as well as the geographic and cultural cohesiveness of the village. Whilst there is some evidence of the impact of strengthened VEDCs on community awareness of girls' education and increased support to schools and teachers, there continue to be significant challenges in ensuring regular and meaningful community participation, especially with regards to more disadvantaged community members. SEAMEO CED planned and tried to fill the gap by seeking partnerships in domestic, regional and international areas that the Border Schools Project could access.

SEAMEO CED Border Schools Project: A Brief Review

SEAMEO CED has been working on the SEAMEO Flagship Border Schools Project. The Border Schools Project is an Inter-Centre Collaboration that has important origins in Sustainable Development Goal 4 "to achieve equitable and quality education and promote lifelong learning opportunities for all" as well as SEAMEO priority area number 2 "addressing barriers to inclusion and access to basic learning opportunities for all learners through innovation in education delivery and management." The project is currently supported by both the Ministry of Education and Sports in Lao PDR as well as the SEAMEO Secretariat.

The Border Schools Project was initiated by SEAMEO Secretariat and led by SEAMEO CED to address some of the challenges by (1) developing an understanding of the challenges faced by border schools; and (2) addressing the problems of inequity and access to quality education for marginalised communities of SEAMEO Member Countries.

Some of the key focus areas of the Border Schools Project include teaching and school capacity development, increased community involvement and engagement, and the development of networks and resources (including partnerships between VEDC and SEAMEO CED).

In the early year of 2019, SEAMEO CED organised an international workshop for presenting the issues and challenges that exist in the Border Schools.

Challenges and Opportunity in Border School Development Project

Over the last two years, SEAMEO CED has been emerging as a research, coordination and training organisation that demonstrates leadership in community education development via community-driven research projects connecting education with socio-economic community priorities. The organisation's mandate covers both formal, non-formal and informal education contexts with a significant focus on livelihood development and lifelong learning.

Many SEAMEO Member Countries share their borderlands yet the quality of education received in border schools is generally poor and compounded by factors such as remoteness, poor infrastructure and services, low household and community income, low human capacity and cross-border migration. Significant attention has been paid to actively improve and enhance the quality of education and health in border communities to achieve the SDGs. Border regions also represent significant economic and social opportunities in terms of commercial agriculture and eco and cultural tourism especially in the Myanmar-Lao province of Bokeo and Laos-Vietnam province of Houaphan. Investment in education is a key element to enable border communities to take advantage of these opportunities but also drive the social and economic development of Lao PDR into the future.

In order to better understand the specific challenges of each community, a pilot study was conducted during the year 2019 with school teachers, managers and district office staff. With this they are in better position to understand their main opportunities and constraints and existing resourcing. Some of the common issues faced by border schools included: teaching and education management capacity (for example, teachers received on average about 1.2 training opportunities in eight years). Other challenges include multi-grade teaching, teaching in Lao as a second language and limited knowledge to teach specific subject areas. Moreover, there is a lack of school infrastructure, cross-border land for trade and motivation from their society.

Some potential project activities were identified including training activities and development opportunities in schools to integrate agricultural knowledge into developing the school, village development committee, and community collaboration. The pilot study also identified issues specific to primary schools including unique multi-grade teaching challenges; inappropriate enrolment ages (such as late enrolment ages); smaller student numbers and competing economic activity. There are also additional issues specific to lower secondary schools including decreasing teacher training opportunities, limited community engagement and family support for schooling; pressure to earn economic incomes and the perception that education does not provide economic and job opportunities. Many of these issues are socio-cultural as much as they are poverty-related.

The findings of the pilot were confirmed by representatives from the border schools themselves including Ban Dan and Ban Duey Schools in Houaphan Province who highlighted some of their current opportunities and resources as well as challenges including limited parental support and the need to develop strategic planning and school management skills. Houay San and Phadam schools in Bokeo Province had similar challenges, and Kengkang Primary and Nonsamphanh School in Champasak identified the need to develop teaching resources and to build teaching skills in specific subjects. Santhong Lower Secondary School in Vientiane Capital identified the need to develop their capacity in specific subjects and highlighted the value of working with parents to support school attendance.

The visit to Samphanna Lower Secondary School Border with Thailand highlighted the important role of students, families, and the community in ensuring that schooling is a positive experience. The students demonstrated that many of them face the challenge of managing “double identities”. This mismatch creates significant issues in terms of the movement of students for economic reasons to support their families. It was also clear that more work needs to be done in order to develop a better understanding of the aspirations and motivations of students and families. The project also created a space to match the needs of Border Schools with existing capacity and skills within SEAMEO Centre’s in order to develop a way forward via a joint planning session identifying amongst other things areas for collaboration and where more research is required.

In order to address some of these issues, a trial of student activities was carried out at Namsang Secondary School in Santhong District in order to connect agricultural students from the National University of Laos (NUOL) with some of the current livelihood concerns identified in Santhong District, Vientiane Capital. A series of activities were carried out from 6-10 May 2019 in conjunction with school students to demonstrate practical agricultural science-based activities that had practical value for the community. The main objectives of the activities were to promote learning and awareness as well as introduce students to clean agriculture – including compost and animal feed production as well as simple food processing from local plants. In subsequent interviews, many students from Namsang School reported the value of these practical activities that did not occur often in the community – enabling them to not only build their knowledge and skills but also enjoy new friendships. A total of 337 students enthusiastically participated in the activities which were well supported by teachers who commented on how they wished that activities occurred over a longer time frame and requested annual activities in the future.

Issues in Broder Schools: Case Study Contexts

Findings in Huaphanh Province

In Huaphanh Province, where the School Border with three Provinces of Vietnam is located in the northern part of Lao PDR and is about 650 Kilometers from Vientiane Capital. It is an upland province and is covered by forest (76%), mountain (16%) and rice fields (8%). A total 13.44% of households are one of the poorest in Lao PDR. It has one of the highest rates of multigrade classrooms (62 % in 2015) in Laos.

Viengxay District is located in the Northeast of Huaphan Province and is 28 kilometers from the Huaphan Province centre. Viengsay District has 14 village clusters, 104 villages, 5,782 households and 7,070 families with a total population of 32, 647 People. There are five major ethnic groups (Thaideng 58.85%; Lao 14.76%'; Kamu 14.30%, Hmong 9.30%; Emien 2.35%).

Ban Dan and Ban Duey Primary Schools are located in Viengxay District Huaphan Province and are rural communities heavily reliant on agricultural production and livestock. The school has major multigrade classroom issues. For example, grades 1-2-3 study in the same class and grades 4-5 are in the other class. The school has a temporary building that was located in the centre of the village.

The number of challenges of Ban Dan, Ban Deuy are listed as follows: (1) Director lacks strategic plans and management skills, (2) Teachers lack management and multi grade-teaching skills, (3) Lack of teacher guidelines, students guide books, toys, and equipment to facilitate teaching and learning, (4) Village Education Development Committee's inactivity to apply their roles and responsibilities, and (5) Parents' reliance on only teachers to teach their kids at school, and lacking motivation and encouragement for their kids to go to school thus, students' learning outcomes remain low.

Findings in Bokeo Province

Bokeo Province is located in the Northern Province in the west-east of Laos. It is located about 894 km from Vientiane Capital, with 70% of the total area is mountainous. Bokeo shares a border with Thailand and Myanmar. The province is generally poor.

Merng district is in the west-east of Bokeo Province has five village clusters with 28 villages, with 15,754 people. There are eight ethnic groups in Merng: Leu 22.10%, Lahoo 44.25%, Ahka 16.94%, Hmong 6.88%, Kmu 2.70%, Ill-mien 2.60%, Lamead 1.9%, and Yuan 3.20%.

The major issues that were faced by the school include: (1) Grade 5 students' low chance to reach to Grade 6; (2) low transition rate between grades; (3) high drop-out rate as students follow their parents to production fields; (4) teachers' limited teaching skills and lack of knowledge; (5) lack of resources such as library and books; and (6) parents' inability to speak the Lao language.

Findings in Vientiane Capital

Vientiane Capital, the capital city of Laos has a total area of 3,920 square kilometres. The population is about 900,000 and the average density is 200 people per one meter. The landscape is mostly river plain and there are two main rivers the Mekong and Nam Ngum which shared the border with Thailand. Vientiane capital consists of nine districts and some districts are located on shared traditional and international borders with Thailand.

Sangthong district is located in the centre of Vientiane to the northwest which is about 55 kilometers and has 35 villages (with 13 villages along the Lao-Thai border). The population of Santhong is 30,747 and consists of three ethnic groups which are Lao lom, Kuemmu and Hmong. There are seven secondary schools, two lower secondary schools, primary schools, 10 preschools and 10 kindergarten schools.

Schools in this district face some challenges that include: (1) poor learning outcomes of students (2) lack of teaching experiences for some subject teachers; (3) insufficient teaching materials; (4) insufficient teachers' office space; (5) lack of water for gardening; and (6) lack of school infrastructures such as school fences.

Findings in Champasack Province

Champasack Province is located in the Southern Part of Laos and it is around 700 km away from Vientiane Capital city. It has a land area of 153,500 ha, and population of 714, 364. Champasak Province shares a border with Thailand and Cambodia.

Sukuma District is located far from the city of Champasak around 64 kilometers, and has six groups of education which include 56 villages and the total population is 56,000. There are three ethnic groups such as: Lao 76.9 %; Suay 22.39 %; Khmer 0.65 %.

Phonthong District is located far from the city of Champasak along the South around two kilometers, it has nine groups of villages which include 71 villages. The total number of populations is 99,374 (women 50,745) which include two ethnic groups.

The border schools in both districts have many challenges such as (1) Grade 5 students' low chance of reaching Lower Secondary Education Level due to parents' inability to support further education; (2) weakness of students in Lao language, mathematics, English and others; (3) students in low socioeconomic status with parents who do not understand how education is important for their children; (4) lack of learning and teaching materials; (5) school's inaccessibility, especially those who live far; and (6) VEDC lack of involvement in education development.

Discussion

The findings have demonstrated that to respond to the challenges in the border schools, VEDC has taken their roles. VEDCs seem to be active in problem analysis, identifying priority needs, and simple strategies to address the needs of the communities. However, there are also challenges in ensuring that all members are committed to and capacitated for their roles. Most VEDCs meet fairly regularly, but not on the monthly basis as recommended in official guidance.

Moreover, due to lack of access to training programme for their capacity building, VEDCs have not yet fully grasped, much less, fulfilled their roles and responsibilities in their communities.

In addition to top-down policies, it has received insufficient investment from the government. Additionally, the members of VEDC have focused more on their family business for their livelihood.

Furthermore, the study also found that Border School students are often affected by outside factors that are beyond their control including human trafficking, cross-border illegal works, and illegal trading. On the other hand, community school infrastructure remains poor, the school lacks teachers in some subjects, and students lack of encouragement from their parents and communities. This study recommends that stakeholders should work closely with VEDCs and motivate them to be more effective in supporting student's enrolment, improving infrastructure, and making various kinds of contributions to school development.

Conclusion

Given the role of the SEAMEO CED in running a number of community-based activities - including vocational, basic education and literacy pieces of training, developing teaching materials, capacity building of school leaders, teachers and curricula on various themes, up-skilling of Master trainers, providing adult education training across sectors and providing monitoring and evaluation from SEAMEO Secretaries - it is well placed to design and implement a pilot project for 'Promoting Community-based for Sustainable Development in Asia and the Pacific'. VEDCs is another partnership to support communities in embedding quality learning in their pursuit of sustainable development. The implementation process is evaluated and recommendations for improving the Border Schools Project are developed and provided to SEAMEO member's countries to be applied in responding to their borderland countries issues.

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Educational Cooperation through SEAMEO in Japan

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Abstract

The Ministry of Education, Culture, Sports, Science, and Technology (MEXT) has been actively collaborating with SEAMEO to support the development of education, science, and culture in the Southeast Asia region since the 1970s. This paper presents the history of cooperation with SEAMEO by the Japanese government. The MEXT's educational cooperation programmes, namely, "SEAMEO-Japan ESD Award" and "Programme of Dispatching Experts" by the MEXT are introduced and plans for Japan's further cooperation with SEAMEO are focused.

Keywords: Education cooperation, SEAMEO-Japan ESD Award, MEXT, Programme of Dispatching Experts

Introduction

The Japanese government currently provides a broad range of cooperation to Southeast Asia in the area of education that includes high school and university student exchanges, the internationalisation of higher education, and educational cooperation through the Japan International Cooperation Agency (JICA). In this paper, we focus exclusively on cooperation through SEAMEO.

The Japanese government's cooperation with SEAMEO began in 1970 with the dispatch of Japanese experts to SEAMEO by the Ministry of Foreign Affairs (MOFA). Between 1970 and 1997, MOFA cooperated with SEAMEO in various ways, including dispatching Japanese experts, supporting the SEAMEO Educational Development Fund, providing aid for the purchase of equipment, and protecting cultural heritage.

The Ministry of Education, Culture, Sports, Science and Technology (MEXT) has participated as an observer in the SEAMEO Governing Board since 1977. Later, in 2011, MEXT launched two educational cooperation programmes for SEAMEO — the SEAMEO-Japan ESD Award (SEAMEO, 2020) and Programme of Dispatching Experts.

In addition to these Japanese government initiatives, the University of Tsukuba has been providing educational cooperation, particularly in science and mathematics, since 2009 as an affiliate member of SEAMEO.

SEAMEO-Japan ESD Award

Education for Sustainable Development (ESD) aims to nurture future leaders in sustainability by providing the kind of education that encourages people to view global issues as their own and equips them with the ability to think and act for themselves to tackle those issues (UNESCO, 2020).

At the World Summit on Sustainable Development held in Johannesburg in 2002, Japan's then Prime Minister KOIZUMI Junichiro proposed the ESD initiative; in the same year, the United Nations Decade of Education for Sustainable Development (2005–2014) was adopted at the 57th Annual General Assembly held in New York. ESD has been pursued subsequently by UNESCO within the frameworks of the Global Action Programme on Education for Sustainable Development (GAP, 2015–2019) and ESD for 2030 (2020–2030).

In 2012, MEXT and SEAMEO started the SEAMEO-Japan ESD Award with the following objectives:

1. To raise awareness of ESD in schools and communities across Southeast Asia;
2. To promote ESD best practices in schools and communities across Southeast Asia;
3. To share and exchange knowledge and best practices on ESD in schools across Southeast Asia and Japan;
4. To encourage networking among schools and communities which implement ESD practices in Southeast Asian countries and Japan; and
5. To support the Sustainable Development Goals (SDG) of the United Nations.

Under this programme, MEXT and SEAMEO set an ESD-related theme each year, and the SEAMEO Secretariat calls for schools in member countries to submit applications describing initiatives that match the given theme. The judging committee screens all of the applications and selects the most impressive three initiatives for the award of 1st, 2nd, and 3rd prizes at a ceremony held at SEAMEO's headquarters in Bangkok. The 1st prize is a cash award of USD 1,500, the 2nd prize USD 1,000, and the 3rd prize USD 500. This programme attracted a total of 617 applications between 2012 and 2019.

The themes of the SEAMEO-Japan ESD Award from 2012 to 2020 are as follow:

- 2012: Education for Disaster Risk Reduction
- 2013: Values Education
- 2014: Fostering Global Citizenship for Sustainable Future
- 2015: Safeguarding our Cultural Traditions
- 2016: Saving Energy
- 2017: Improving Health and Nutrition
- 2018: Applying Local Wisdom for Environmental Conservation
- 2019: Building Peace in Schools and Communities
- 2020: Addressing Plastic Problems for Transforming Communities

Examples of activities provided to the winners are given of the Award winners in 2018 and 2019 below.

Figure 1. *Theme for 2019: Building Peace in Schools and Communities*
1st Prize: South Hill School, Incorporated (Philippines)
Title of the school's programme: Kindness for PEACE

MEXT also invites several teachers and students from schools that win the 1st Prize to Japan for a study tour. Participants in these tours learn about Japan's education and culture through visits to MEXT, UNESCO Associated Schools, historical sites, museums, and other facilities. Visits to UNESCO Associated Schools are particularly worthwhile for they enable the students of both countries to interact. UNESCO Associated Schools are the schools that support peace and international cooperation to achieve UNESCO's purpose as shown in its Constitution. It is this purpose that underpins the promotion of ESD. There are approximately 11,500 UNESCO Associated Schools in 182 countries and territories worldwide, including 1,120 schools in Japan as of November 2019 (UNESCO Associated Schools Network, 2019).

Figure 2. *2018 1st prize winner: Widya Mukti Vocational School (Indonesia)*
March 2019 Japan Study Tour and Visit Shimofusa High School (UNESCO Associated School) in Chiba Prefecture

Programme of Dispatching Experts

In 2011, MEXT launched the Programme of Dispatching Experts under which Japanese experts are dispatched to conduct training, symposiums, and other activities based on requests from SEAMEO Regional Centres. A total of 51 experts were dispatched to 13

SEAMEO Centres from 2011 to 2019. Their areas of expertise included mathematics, science, history, tropical biology, ICT, and special support for students with disabilities.

Figure 3. *Workshop on Computational Thinking through Designed-based in Classroom Context, November 2019 at SEAMEO QITEP in Science*

Conclusion

The Sustainable Development Goals (SDGs), which were unanimously adopted at the UN's Sustainable Development Summit in September 2015, are a set of 17 global goals to be achieved by 2030 for creating a sustainable, diverse, and inclusive society that leaves no one behind.

The Japanese government is working to achieve the SDGs both domestically and internationally and is pursuing ESD as one of its initiatives (MOFA, 2020). MEXT will continue to serve as an observer in SEAMEO and help to improve the quality of education in Southeast Asia by promoting the spread of ESD, training educators, and developing curricula and teaching materials through the SEAMEO-Japan ESD Award and Expert Dispatch Programme.

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Inclusive Education and Globalisation: Perspective in University of Tsukuba

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Abstract

The University of Tsukuba was established as a core institution for higher education in line with Tsukuba Science City, which is the largest science city in Japan. The University of Tsukuba is also well known as an institution with a strong background in education. Creation of knowledge is the most important mission in university and inclusive education and globalisation is essential to provide the opportunity for education and research for more people and this would lead to sustainable creation of knowledge. Several activities towards globalisation and inclusive education have been implemented at the University of Tsukuba.

Keywords: Inclusive education, globalisation, sustainable development

Introduction

Globalisation and inclusive education have been widely picked up as important issues for many higher education institutions in Asia (Nomura, 2015; Song, 2016). In Japan, many universities put 'creation of knowledge' as a general mission to be a higher education institution and activities for education and research are set to be in line with this mission. Among activities in universities, human resource development is one the most important items because human resources could be an important form of knowledge as well as an asset to support the continuous creation of knowledge in the future.

In Japan, the style for human resource development needs to be reformed due to the decrease of 18 years old population (Nomura, 2020). Japanese universities are trying very hard to strengthen globalisation and inclusive education to keep sustainable creation of knowledge. In this article, activities for globalisation and inclusive education at the University of Tsukuba are going to be introduced.

The University of Tsukuba was opened as the core higher education institution in Tsukuba Science City, which was established as the largest hub of sciences and technologies in Japan in 1970. The University of Tsukuba has also nearly 100 years of history as a university focusing on higher education located in Tokyo and its origin is Tokyo Higher Normal School. Since the University of Tsukuba has strength both in science/technology and education, activities introduced in this article could serve as a good practice for many higher education institutions in Southeast Asia.

Academic activities towards nurturing 'Global Human Resources'

The University of Tsukuba is known as a globally opened university. This can be observed in a high ratio of international students over domestic Japanese students as well as the number of degree programmes that are taught all in English. The ratio of international students at the University of Tsukuba reached the highest among that in other public universities in Japan in 2017. Actually, the number of international students has been rapidly increasing since 2010. One of the epoch-making events for this was a national project called 'Global 30' launched by Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan in 2009 (MEXT, 2009). This project was aiming to boost up the number of inbound international students in Japanese universities. Through strict screening by MEXT, 13 universities (seven public and six private universities) were selected as the proponent for the project as well as the recipient of government subsidy (Table 1).

Table 1. *Universities under 'Global' 30 Project*

National Universities (7)	Private Universities (6)
Tohoku University	Keio University
University of Tsukuba	Sophia University
University of Tokyo	Meiji University
Nagoya University	Waseda University
Osaka University	Ritsummeikan University
Kyoto University	Doshisha University
Kyushu University	

Activities implemented under the Global 30 included overseas student recruitment, career development for international students during the study in Japan, opening overseas branch offices, etc. Among several activities, the action which all 13 universities took was opening degree programmes that were all taught in English. This is because all 13 universities realised that the reason that international students were not selecting Japanese universities was the necessity to have Japanese language proficiency to study in a degree programme in Japanese universities. At the University of Tsukuba, three bachelor programmes were opened in line with launching the Global 30 project, and three more bachelor programmes targeting inbound international students have been opened until 2019 (Table 2).

Table 2. *Bachelor's Degree Programme offered for Inbound International Students by University of Tsukuba*

Interdisciplinary Programme for **Life and Environmental Sciences** <Biological Sciences, Agro-Biological Resource Sciences, Geo Science>
Undergraduate Programme for **International and Social Studies** <International Studies, Social Studies>
Undergraduate Education Programme for **Medical Sciences** <Medical Sciences>
Bachelor's Programme for **Global Issues**
Japan-Expert Programme <Japanese Language, Agronomist, Health Care. Japanese Art>
Bachelor's Programme in **Interdisciplinary Engineering** <Natural Science, Engineering>

It is reported that the Global 30 project was successful in increasing the number of inbound international students in Japan. At the University of Tsukuba, the number of inbound international students increased from 1,442 (as of 2008) to 2,732 (as of 2017) (Nomura, 2020) as shown in Figure 1.

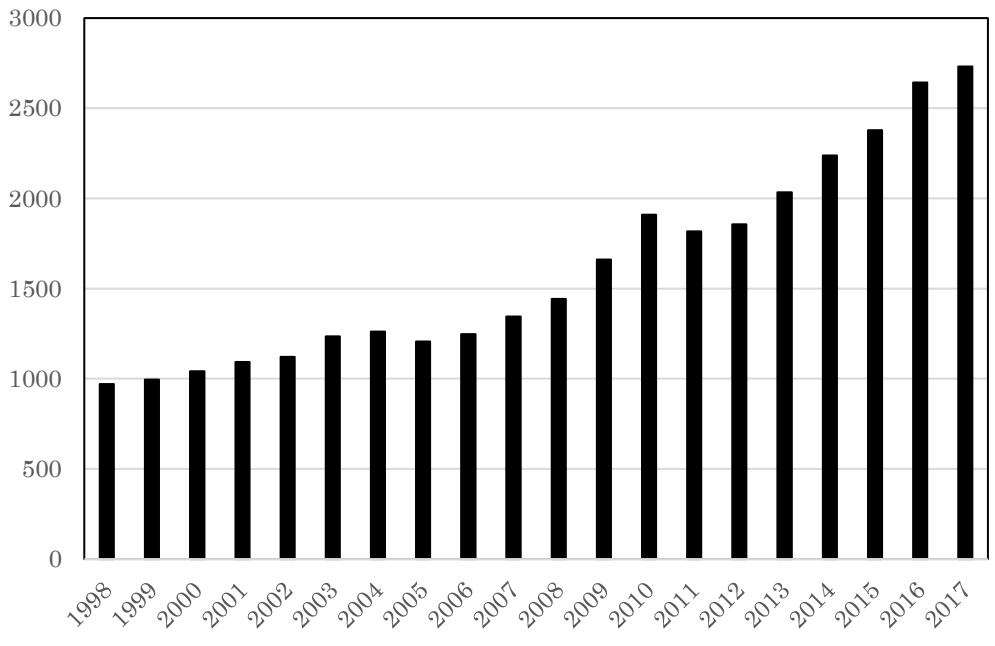

Figure 1. *Total number of inbound international students in University of Tsukuba*

At the University of Tsukuba, opening bachelor programmes that are all taught in English are not only for inbound international students for four-year degree but also for exchange students from overseas partner universities with an academic agreement.

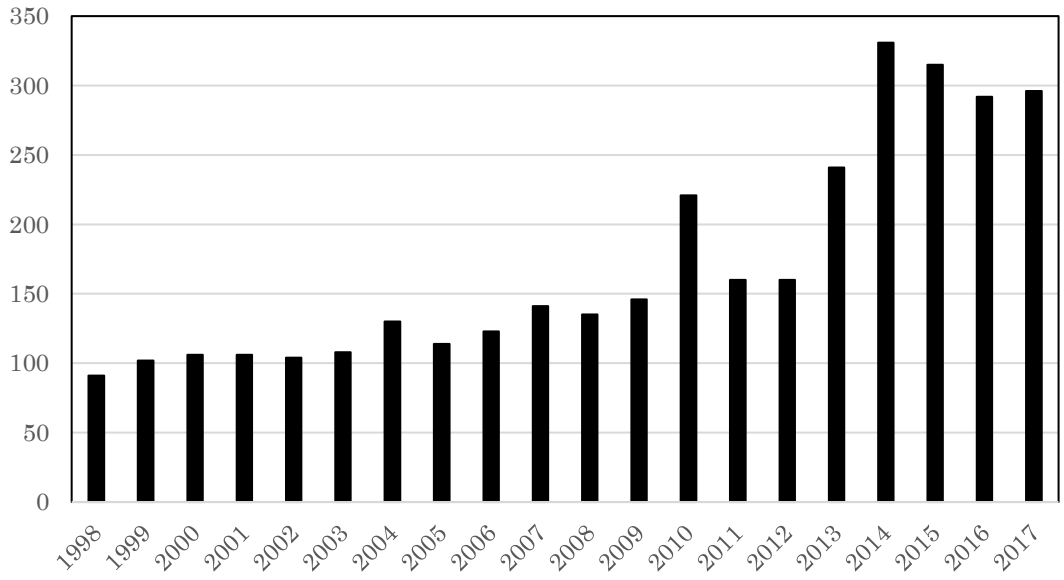

Figure 2. *Total number of inbound international short-term exchange students in University of Tsukuba*

Before having a bachelor's degree programme that is all in English, exchange students from partner universities were mainly students majoring in Japanese language/culture or students who would like to conduct graduation thesis research with instruction by a host professor at the University of Tsukuba. However, after opening bachelor's degree programmes that are all in English, students in various majors were admitted to the University of Tsukuba as exchange students (Figure 2).

If we can define inclusiveness in inclusive education as the provision of educational opportunity across borders, it can be said that degree programmes receiving lots of international students at the University of Tsukuba are contributing to strengthening inclusive education (University of Tsukuba, 2015).

Educational Programme for Inclusive Education

As can be seen in the origin of the University of Tsukuba as Tokyo Higher Normal School, the University of Tsukuba has a long history in education as a study field in university. Inclusive education has also been practiced since its foundation. In this section, programmes for inclusive education are being introduced.

College of Disable Sciences

As a bachelor's degree programme with a major in special education, the University of Tsukuba has a College of Disable Sciences (University of Tsukuba, 2020). This college is aiming to develop human resources who can contribute to human life and society by providing students with opportunities to study disability scientifically, as well as education about specific forms of support for people with disabilities, and the foundations of such support, as well as the essential features of being human.

Doctoral Programme in Disability Sciences

The University of Tsukuba also provides a degree programme for graduate school level in the field of disability sciences. Doctoral Programme in Disability Sciences provides opportunities for facilitating research on various disability-related practical issues such as researchers and educators with advanced research and education on the disability sciences. This programme is aiming to nurture professionals with high-level expertise who can perform and provide research, education, and instruction. Faculty members of this programme are with a wide range of expertise in the disability sciences from fundamental theory to practice.

Early Completion Doctoral Programme

In Japan, the demand for recurrent education for people in business sectors is increasing (University of Tsukuba, 2020b). Particularly, people handling business projects which need a high level of skills or knowledge tend to come back to pursue doctoral degrees to do research studies that could bring benefit to their projects. However, challenges for people in the business sector to be admitted into a doctoral programme is time availability to commit to degree study for several years. The University of Tsukuba provides a doctoral degree programme targeting those people. This doctoral programme is called the 'Early Completion Doctoral Programme' and is provided for applicants with certain achievements (checked in entrance selection procedures) in academic research. The doctoral degree could be completed in a minimum of one year (maximum three years). The programme also provides academic courses to gain capacity in terms of communication skills and global understanding as a postdoctoral researcher. Fields of study covered by this programme are Pure & Applied Sciences, System and Information Engineering, Life & Environmental Sciences as well as Business Sciences.

Degree Programmes taught in English

As mentioned in the introduction, the University of Tsukuba offers several bachelor programmes targeting mainly international students. At the graduate school level, there are more programmes that are all taught in English. Since most graduate programmes in Japan are research-oriented (not course work-oriented), study for Master's or doctoral degree can be done as long as communication with the research supervisor and thesis committee, and the thesis can be done in English. There are 20 Master's programmes and 6 six doctoral programmes that are all taught in English. In addition to this, there are several double/joint degree programmes with partner universities abroad (University of Tsukuba, 2020a).

Diversity, Accessibility and Career (DAC) Center

The University of Tsukuba has an organization to facilitate the campus with inclusive education. This organisation is called Diversity, Accessibility and Career (DAC) Center whose staff are composed of both administrative and teaching staff (University of Tsukuba, 2020c). The Head of the Center is an executive director of the university, which is one of the members

of the university's management committee. DAC Center is promoting mutual understanding about gaps due to gender, generation, nationality, and disabilities. DAC Center provides comprehensive supports for students/staff/faculties with disabilities, development and orientation of career for students and LGBT (lesbian, gay, bisexual, transgender).

Conclusion

As can be seen in a drastic increase in the number of inbound international students, globalisation at the University of Tsukuba has been progressing with the introduction of several activities for inclusive education. The increase of people with a different background in culture and language has brought opportunities to bring more changes to the university campus. Differently from universities in Japanese metropolitans such as Tokyo or Osaka, most inbound international students can be accommodated in on-campus housing or residence hall very near from university campus. This situation has brought changes to the campus living environment to be more barrier-free and borderless.

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Building International Learning Networks for ESD and SDGs: A Case Study of Collaboration Among High Schools in Japan and ASEAN

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Abstract

This article highlights the importance of building international learning networks for ESD and SDGs. As the world becomes increasingly globalised, it is important to build a global network among high schools in order to realise the universal, inclusive and integrated educational activities raised in the SDGs of the UN. The University of Tsukuba (UT) and its laboratory school, the Senior High School at Sakado (UTSS), have held international symposiums in cooperation with universities and their laboratory schools in Indonesia, Thailand, and the Philippines, and established an international network through JICA's overseas teacher dispatch programme. This has led to international collaborative learning among high school students and the continued holding of international symposiums for high school students. UTSS became the first school in Japan to accept the SEA-teacher pilot project in 2020, based on its experience in collaborating with ASEAN countries. The programme has not only been a teaching practice with international experience and networks but has also led to teacher training at host schools, as well as the promotion of international understanding among high school students. In order to build a sustainable society and realise world peace in the future, it is hoped that the acceptance of these types of inter-country training will increase.

Keywords: High schools, ESD, SDGs, collaborative learning, SEA-teacher

Introduction

In Japanese high schools, two major projects on global education are currently being implemented by the Ministry of Education, Culture, Sports, Science and Technology (MEXT). The first is the "Super Global High School Project" (SGH), which was launched in FY 2014 (https://sgh.b-wwl.jp/en/). The second is the "Support for the establishment of the World Wide Learning Consortium" (WWL), which has been implemented since FY 2019 (https://b-wwl.jp/base_en/). In both projects, each school is required to deepen cooperation with universities, international organisations, etc., to set specific global social issues such as sustainable development goals (SDGs), and to make efforts for learning in problem solving. In order to realise these goals, it is important for high schools to have opportunities to collaborate with various stakeholders and to train high school teachers in international education.

In this context, many high schools in Japan are considering building an international network with overseas institutions. A number of cases have been reported in which Japanese and ASEAN universities have collaborated, wherein teachers and students have visited high schools in the countries to conduct classes at high schools (Cuong, et al., 2016; Nomura, et al., 2018). However, there have been few reports of high schools taking the initiative in building international networks and promoting global education for high school students, or of activities in which high school students collaborate with each other.

In this paper, I present two examples of building international high school networks, namely: (1) an international network in cooperation with universities; and (2) an international network created by JICA's Teacher Dispatch Programme. As examples of the development of the international network, this paper shows the development of international collaborative learning, the holding of international symposiums mainly for high school students, and participation in international teacher training programmes such as the acceptance of the SEA-teacher pilot project. Based on the above, I summarised the importance of building international networks for ESD and SDG in high schools.

Building an international network through collaboration between universities and its laboratory schools

UTSS has been designated as SGH and WWL, which foster global education. In particular, UTSS collaborates with laboratory schools of universities of ASEAN countries in coordination with UT. In 2008, UT, in cooperation with the Bogor Agricultural University in Indonesia (IPB), started a collaborative project with MEXT to develop environmental education materials using bamboo charcoal at Lab school SMA Kornita. Thereafter, the "Laboratory School Teachers Forum" was held at the Tsukuba International Agriculture ESD Symposium in 2010, which was attended in by laboratory schoolteachers from four countries (Ardales Jr., 2011; Widodo, 2011; Techakosit, 2011; Tatemoto, 2011). Guided by international exchange among universities, the laboratory schools commenced international cooperation agreements via teachers and students exchanges; the conduct of international symposiums, mainly composed of high school students; and the development of international collaborative learning programmes, as shown in Figure 1.

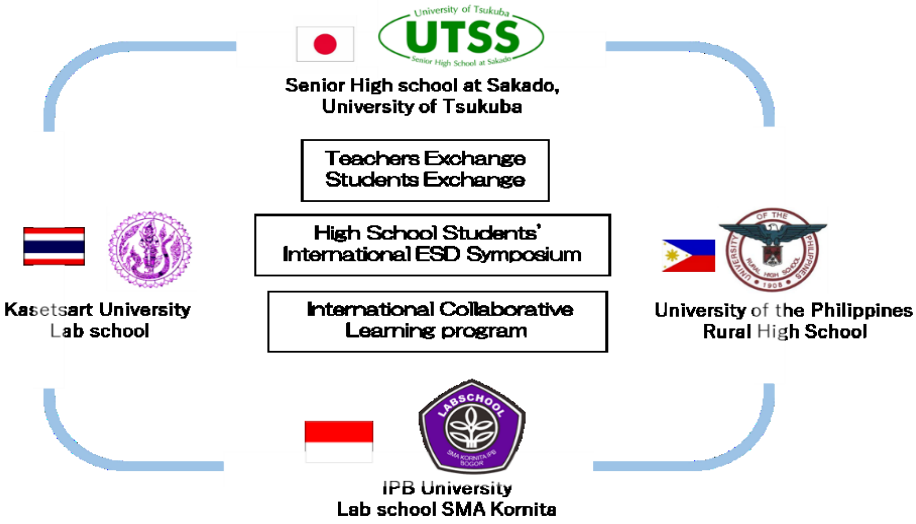


Figure 1. *International Learning Network of High Schools in Japan (UTSS) and ASEAN*

Table 1 summarises the partnership agreements concluded with each country over the past five years. UTSS has already been in contact with Kornita for 10 years, with active collaborative learning in SGH and WWL. In addition, exchanges with the University of the Philippines Rural High School (UPRHS) and Kasetsart University Lab School (KULS) have deepened, which include mutual support for graduation research activities and the acceptance of one-year study abroad programmes for students. After COVID-19, direct communication was stopped, but we would like to maintain and develop the network by utilising online learning.

Table 1. *The year of making Partnership Agreement and the mobility results of the last five years (2015 – 2019)*

Country	Indonesia	The Philippine	Thailand
School	IPB University	University of the Philippines	Kasetsart University
	Lab school SMA Kornita	Rural High School	Laboratory School
Year of Making Agreement	2010	2016	2017
To Japan	5(T), 36(S)	8(T), 21(S)	5(T), 12(S)
From Japan	15(T), 41(S)	8(T), 8(S)	9(T), 3(S)

T: The number of teachers, S: The number of students

JICA's Teacher Dispatch Programme

The Japan International Cooperation Agency (JICA) has a programme that sends Japanese to foreign countries as volunteers called Japan Overseas Cooperation Volunteers or JOCV. In particular, there is a system in which teachers from public schools, national and public university affiliates, private schools, etc., can participate in JOCV programme while maintaining their teacher's status. JOCVs often have opportunities to work at government agencies and schools in the host country, as well as training opportunities. Therefore, they have the opportunity to build an international network. After returning home, they can play a role in promoting international educational activities in school. I was assigned to a national park managed by the Indonesian Ministry of Environment and Forestry when I participated in the JOCV programme from 2008 to 2010 (Tatemoto, 2011). Even after returning to Japan, exchanges with Indonesia continued. In 2012, UTSS had the opportunity to exchange with the Forestry High School attached to the Ministry of Environment and Forestry (SMKK) through JICA experts, and partnerships were deepened. UTSS and SMKK are promoting a programme similar to Figure 1. JICA's Teacher Dispatch Programme has had about 60 to 100 participants from all over Japan every year since its launch in FY 2001 (Figure 2). It has already been dispatched to about 100 countries, and is expected to play a role in promoting ESD and SDGs at schools.

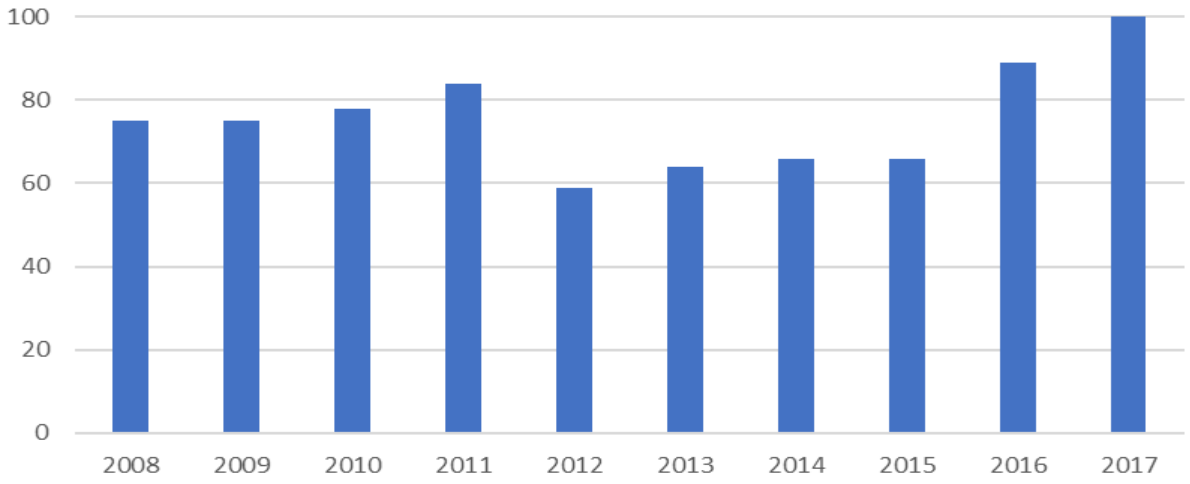


Figure 2. *Number of teachers that have participated in the JOCV special programme*

Excerpt from: https://www.jica.go.jp/volunteer/relevant/school/incumbent/achievement/index.html

Development of International Collaborative learning Programmes by International Teachers' Network

International fieldwork in Indonesia

Following the designation of UTSS as SGH in 2014, UTSS has collaborated with two Indonesian schools to develop an international collaborative learning programme from the perspective of the ESD and SDGs in a national park area in West Java (Tatemoto & Junko, 2020). Participants are selected at each school and a total of 21 students – seven from each school – participate every year. More than 100 students have already participated. A total of 21 students from Japan and Indonesia are divided into three teams of seven to work together on forest conservation. The three teams, namely, "Environmental Education", "Ecotourism", and "Community Development", developed forest conservation activities based on the voluntary ideas of high school students from their respective perspectives. The activity examples of each group are shown in Table 2 and Figure 3. Teachers from the three schools hold prior meetings to discuss the content, and during fieldwork, provide guidance to the participating students. This experience has also led to teacher training in global education.

Table 2. *Examples of collaborative activities between Japanese and Indonesian high school students*

Group	Activities
Environment Education	Development of a simple soil experiment kit using locally available materials
	Performance of an environmental drama on the theme of wildlife conservation in elementary school
Community Development	Market research for tourists of local specialties (soap, sambal sauce)
	Paper making with non-timber resources using banana leaves
Eco Tourism	Making of guidebooks in three languages (Japanese, English, Indonesia) and distribution of PDF version
	Making of local promotional video and uploading to the website

a) Interview about local products to visitors

b) Drama performance at an elementary school

Figure 3. *Collaborative activities between Japanese and Indonesian high school students*

High School Students' International ESD Symposium

UTSS, with support from UT, has held this event since 2012, and held its ninth symposium in 2020. High school students are mostly in charge of the management of the activity, including the moderation and reception. Since the UN raised the SDGs, these have been incorporated into the main theme of the symposium (Table 3). Each school presents their SDGs-related activities and research results orally and via posters (Figure 4). High school students from Singapore, Canada, Australia, and other countries, including Indonesia, Thailand, and the Philippines, with which UTSS has concluded partnership agreements, also participate. Japanese high school students are also participating. Companies and international organisations also participate. These have led to international school exchanges and relationships with new multi-stakeholder folders.

Table 3. *Main theme of International High School ESD Symposium @ Tokyo*

Year	Main Theme
2016	SDGs and High School Students – 17 goals to change our world
2017	SDGs x High School Students – We Are the Change Makers for 2030.
2018	SDGs x High School Students – What will YOU do to make tomorrow's world better?
2019	SDGs x High School Students -Which problems do you think of first?
2020	The great transformation for 2030

a) International ESD symposium 2019 at UT Tokyo campus

b) Collaborative presentation among Japanese and Indonesian high school students

Figure 4. *High School Students' International ESD Symposium in Tokyo*

Development of international collaborative learning materials from the perspective of SDGs

With the support of teachers from Thailand and Indonesia, a textbook for international collaborative learning using the migratory bird "HACHIKUMA" (*Pernis ptilorhyncus*, English: Oriental Honey Buzzard) as its flagship species has been created in three languages (Japanese, English, and Indonesian). HACHIKUMA breeds in Japan from July to August, and then migrates to mainland China and Southeast Asia. Some of them migrate to Borneo and the Philippines. It is a species related to the four countries that have a partnership agreement, and I thought it was the best species for promoting collaborative learning. The Bogor Agricultural University is also actively researching the characteristics of its habitat (Syartinilia et.al., 2015). In order to preserve migratory birds, it is necessary not only to understand the ecology of birds, but also to comprehensively learn various events related to the conservation of their habitat. International cooperation is also necessary. At the International High School ESD Symposium held in November 2019, high school students from four countries discussed ideas for cross-country collaborative activities to conserve HACHIKUMA. International collaborative learning related to SDGs will also be made possible through collaboration between high schools in Japan and ASEAN (Table 4 and Figure 5).

Table 4. *Seven Topics of International collaborative learning programme using 'Hachikuma'*

Chapter	Topics
1	Migration Route of the Oriental Honey Buzzard
2	Food of the Oriental Honey Buzzard and the Red List
3	Birdwatching and Ecotourism
4	Environmental Education
5	Ethical Consumption
6	Corporate Social Responsibility
7	What can high school student do?

Figure 5. Idea map created by high school students from the four countries

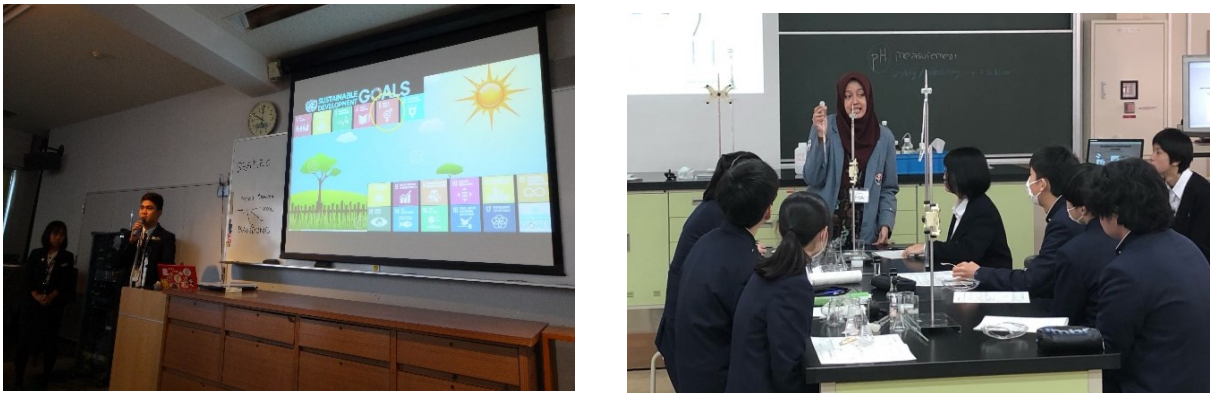
Challenge for SEA-Teacher Programme Using experience of collaboration with high schools in ASEAN

Based on approximately 10 years of collaboration with Indonesia, Thailand, and the Philippines, UTSS became the first school in Japan to accept students of the SEA-teacher pilot project, which was implemented in February 2020. A total of six students were accepted, two each from the Indonesia University of Education, the Khon Kaen University in Thailand, and the Central Luzon State University in the Philippines. UTSS has Indonesian and Filipino English teachers, as well as students from Thailand. These have also contributed to the smooth acceptance of SEA-teacher students through support in their daily living as well as practical training.

What I would like to propose as a host school is that the SEA-teacher programme would not only be an educational practical training programme, but also an international experience for the students of the host school as well as teacher training for the host school. It is also expected to deepen mutual understanding among the parties concerned and help build an international network. When SEA-teacher students work in actual schools, they already have international networks with multiple countries. This is expected to contribute to teachers who can take concrete action on educational issues that require international cooperation, such as Education for Sustainable Development: Towards achieving the SDGs (ESD for 2030) from UNESCO (UNESCO 2020). Although only UTSS has accepted students in Japan, it is expected that more Japanese schools will participate in the programme in the future, thereby deepening cooperation between Japan and ASEAN and developing more collaborative educational activities.

Table 5. *Outline of SEA-Teacher Pilot Project at UTSS*

Period	6th Feb – 27th Feb, 2020 (21 Days)
Number of Students	6 (Indonesia 2, Thailand 2, The Philippines 2)
Accepted subjects	Chemistry, Biology, Civics, English, Agriculture, Home economics



a) Lecture on SDGs in the Philippines b) Chemistry class by Indonesian students

Figure 6. Classes by SEA-teacher students

Conclusion

Building an international learning network will lead to the development of universal, inclusive and integrated international programmes as envisioned in the SDGs, and will increase the participation of high school students who will lead the next generation in solving global social challenges. In order to realise concrete international projects in schools, it is important to build a network among teachers across countries. For this purpose, it is important to continue to hold projects and international symposiums based on international networks, and to develop international teacher training programmes. This study has showcased cooperation among Japanese and ASEAN high schools. The joint development of international collaborative learning on the theme of SDGs, the holding of international symposiums mainly for high school students, and the SEA-teacher Pilot Programme are good examples of international cooperation. It is hoped that such networks will spread to countries and regions around the world. UTSS would like to continue to deepen cooperation with high schools in ASEAN countries and provide examples of international educational activities at high schools.

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Digital Competence for Industrial Revolution 4.0: Implications to Teacher Professionalism

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Abstract

Advancements in digital technologies as well as in their uses continuously happen in the realm of Industrial Revolution 4.0 affecting all facets of man's life, including education. As such, digital competence is necessary. It can be viewed in particular, as an important aspect of teacher professionalism. By citing actual examples, this paper examines the implications of specific digital competencies that bear upon the standards of teacher professionalism in the Philippines.

Keywords: Digital competence, digital transformation, Industrial Revolution 4.0, teacher professionalism

Introduction

Unprecedented advancements in technology have been taking place very rapidly as evidenced by the advent of Industrial Revolution 4.0 (IR 4.0) which is characterised among others by big data, the internet of things, 3D printing, and robotics, all of which are related to digital technologies. Given this reality, digital competence is important. Viewed as "the vital 21st-century skill for teachers and students," it is "the confident and critical usage of the full range of digital technologies for information, communication, and basic problem-solving in all aspects of life" (School Education Gateway, retrieved on 12 February 2020). Digital technologies are "electronic tools, systems, devices, and resources that generate, store, or process data. Examples include social media, online games, multimedia, and mobile phones" (State Government of Victoria, Australia, 2019). The five areas of digital competence are information and data literacy, communication and collaboration, digital content creation, safety, and problem solving; and each area has specific digital competencies (School Education Gateway, retrieved on 12 February 2020). This implies that teachers themselves must be digitally competent in these areas so that they can effectively facilitate the development of digital competence in their students.

Underlying the provisions of the Philippine Professional Standards for Teachers or PPST (2017) is the principle of continuous improvement and lifelong learning of teachers. And so, in the context of IR 4.0, teachers are expected to upgrade and update their knowledge and

skills and exercise values that are necessary for the fast changing times. Content knowledge and pedagogy, learning environment, diversity of learners, curriculum and planning, assessment and reporting, community linkages and professional linkages, and personal growth and professional development are PPST's seven domains which together with their corresponding strands broadly cover the specific digital competences.

This paper will examine some of the specific digital competencies under four of the areas of digital competence and relate them to pertinent standards stipulated in five of the domains of PPST for the proficient, highly proficient, and distinguished career stages of teachers. In the process, it will draw implications to teacher professionalism.

Implications to Teacher Professionalism

Information and data literacy. This competence includes browsing, searching, filtering, evaluating, and managing data, information, and digital content (School Education Gateway, retrieved on 12 February 2020).

Available on the web is a wealth of data, information, and digital content that teachers can access for their professional learning which ultimately can inform their professional practice. They can efficiently and effectively make their access if they have the skills of browsing, searching, and filtering. A critical mind is necessary to evaluate if the resources that they access come from credible and reliable sources. Through the reflection of their purposes and contexts, teachers can determine, use, and manage data, information, research results, e-books, videos, podcasts, lesson plans, activities, presentations, apps, and the like, that can deepen and broaden their knowledge of content and pedagogical content to enhance their teaching and assessment practices. Such competence is consistent with the strand professional reflection and learning to improve practice which is under the domain Personal Growth and Professional Development in the PPST. It is noteworthy that in using these resources on the web, giving credit to whom credit is due by acknowledging the source of ideas through citations is a good practice and demonstrates intellectual honesty.

Integrating into a lesson, a video clip taken from the web is an example of a practice that builds upon information and data literacy. Under PPST's Curriculum and Planning domain, proficient teachers are expected to "select, develop, organise, and use appropriate teaching and learning resources, including ICT, to address learning goals." Appropriateness of the resource should not only be in relation to the attainment of lesson objectives but also in relation to the learners' needs, characteristics, and contexts as provided for in the domain Diversity of Learners of PPST. Still in PPST's Curriculum and Planning domain, proficient teachers are expected to "plan, manage, and implement developmentally sequenced teaching and learning process to meet curriculum requirements and varied teaching contexts." This implies that in adopting or adapting resources such as a video clip taken from the web into a lesson, the teaching sequence should be designed so as to achieve coherence by establishing clear connections among the ideas presented in the different parts of a lesson as well as ideas presented across lessons. Hence, it is very important for teachers to process the ideas presented in the video by finding out if the students correctly and clearly understood what they have viewed and listened to, what these understandings are, and how these relate to their current lesson as well as to their previous lessons.

Again, another example of building upon information and data literacy based on the author's class observations is the lesson integration of interactive courseware in elementary school mathematics in English aimed at developing students' higher-order thinking skills as they learn mathematics. In the different lessons in the courseware, students are required to think of various ways of solving problems, thereby developing their creativity and responding to questions that capture their conceptual understanding including their misconceptions,

thereby developing their critical thinking. The courseware development was a collaborative undertaking of the Department of Science and Technology Science Education Institute (DOST-SEI), UP NISMED, DOST-Advanced Science and Technology Institute (DOST-ASTI) and the Department of Education (DepEd). The resource in which each lesson consists of the activities, fixing skills, and assessment, can be downloaded from the website of DOST-SEI and can run on PCs, laptops, tablets, and netbooks. Teachers translate the lessons in grades 1 to 3 since the mother tongue is used to teach mathematics in these grades in different parts of the country.

The digital competencies needed by teachers who use the courseware in their teaching are aligned with the expectation from highly proficient teachers to "promote effective strategies in the positive use of ICT to facilitate the teaching and learning process" and to "develop and apply effective teaching strategies to promote critical and creative thinking, as well as other higher order thinking skills." These are standards under PPST's Content Knowledge and Pedagogy domain. In fact, the results of the tryout of the courseware in classroom teaching and learning, show that its use has facilitated these processes and may have contributed to the development of desired thinking skills among students. In particular, grade 1 classes that used the courseware had significantly higher mean gain scores than classes that did not use it. This implies that the lesson activities may have helped improve students' understanding of the mathematics covered in the courseware. For the grades 2 to 6 courseware lessons, most of those tried out, may have helped improve students' understanding of the mathematics topics they included. This is evidenced by their significantly higher posttest scores compared with their pretest scores (DOST-SEI & UP NISMED, 2020).

Moreover, as a pedagogical approach, the courseware lessons used teaching mathematics through problem solving. Based on the evaluation of the influence of using the courseware on teaching and learning, almost all of the teacher-respondents claimed that the approach trained their students to think critically and helped them to relate mathematics to real life. In particular, a teacher remarked that with the use of the courseware, her students have their own ways of solving a problem.

Figure 1. *Grade 1 students in Tanauan North Central School doing the task on ordering sets of objects during the tryout*

Figure 2. *Grade 1 students in San Agustin Elementary School enjoy working on the tasks on patterns during the tryout*

Figure 3. *A teacher discussing the answers to the questions on a grade 1 activity in comparing the number of objects in two given sets during the tryout*

Figure 4. *A teacher observing grade 6 pupils as they work on a task during the tryout*

Still, another teacher claimed that with the use of the courseware, her students were trained to think of what they would do because they have a problem to solve at the start of an activity. As far as the teachers were concerned, there was one who used the courseware as her source of mathematics problems that her students solved in class although she could not make them use the courseware itself due to lack of computers. In addition, another teacher reported that she used some of the courseware lessons in class even without her students using the courseware itself. In effect, she experienced what it meant to teach mathematics through problem solving which in turn, provided opportunities for her students to experience what it meant to learn mathematics through problem solving (DOST-SEI & UP NISMED, 2020).

Another example of building upon information and data literacy based on the author's involvement in teacher training programmes is using GeoGebra, a free downloadable dynamic software from the web, to actively engage students in the mathematics teaching-learning process. For instance, teachers can develop tasks that will require students to individually or in groups, carry out using GeoGebra, mathematical explorations or investigations in algebra, geometry, statistics, and trigonometry, say to see the effect of changing a certain quantity on other quantities. In the process, students learn to analyse, make conjectures, predict, generalise, evaluate, and justify. Later, they can prove the conjectures that they have formed based on the relationships that they have observed among the quantities. For this kind of student engagement to happen, teachers have to structure the learning environment so that it will lend itself to students' active involvement. Such is an expectation of proficient teachers as stipulated in PPST's domain Learning Environment. Specifically, they are to "manage classroom structure to engage learners individually and in groups, in meaningful exploration, discovery, and hands-on activities within a range of physical learning environments." They are also expected "to maintain supportive learning environments that nurture and inspire learners to participate, cooperate, and collaborate in continued learning." Moreover, they are to "apply a range of successful strategies that maintain learning environments that motivate learners to work productively by assuming responsibility for their own learning." UP NISMED's GeoGebra Institute of Metro Manila contains apps that can support teachers in meeting these expectations.

Developing lessons that integrate or make use of available resources, say digital content from the web, can be done in the context of lesson study since this teacher professional development model fosters collaborative professionalism (Hargreaves and Connors 2018). For instance, guided by a long-term goal or research theme, teachers, by working collaboratively, can ensure that the lesson objectives are addressed, the correct teaching sequence is followed, and that there is lesson coherence. They can also ensure that there is the processing of the digital content in terms of building up students' understanding of the lesson. During the research lesson implementation, observing how the digital content contributes to students' thinking and learning and discussing about such contribution during the post-lesson reflection are opportunities that lesson study provides. These activities are aligned with the PPST's domain Curriculum and Planning specifically in the strand professional collaboration to enrich teaching practice, in which proficient teachers are expected to "participate in collegial discussions that use teacher and learner feedback to enrich teaching practice."

Communication and Collaboration: This competence includes interacting, sharing, and collaborating through digital technologies and netiquette (School Education Gateway, retrieved on 12 February 2020).

Teachers can interact among themselves, share information and resources, and collaborate to accomplish certain tasks using digital technologies such as Facebook, Skype, and emails. In PPST's domain Personal Growth and Professional Development particularly in the strand professional links with colleagues, it is stipulated that very proficient teachers should be able to "contribute actively to professional networks within and between schools to improve knowledge and enhance practice." UP NISMED's KaSaMa Teachers' Online Community involving science and mathematics teachers and teacher educators as well as UP NISMED academic staff, is an example of an online professional network. UP NISMED has a repository of relevant memoranda from DepEd, learner's modules, and teacher's guides among others, which the community can access. Based on their knowledge and experiences, teachers interact about how to address common problems, for example, those related to teaching science through inquiry. UP NISMED also conducts webinars such as on science inquiry, assessment, lesson study, and new topics in the K to 12 science curriculum in which teachers belonging to the community can ask questions to the resource persons. Members and resource persons come from the Philippines and abroad. Teachers' activities such as these are also consistent with the expectation from highly proficient teachers to "initiate professional reflections and promote learning opportunities with colleagues to improve practice" which is under PPST's Personal Growth and Professional Development domain.

Another example of using digital technologies for communication and collaboration was the cross-border education cooperation between the Philippines and Malaysia in 2017. The activity was undertaken in relation to the APEC Lesson Study Project led by the University of Tsukuba in Japan and Khon Kaen University in Thailand. The theme of the lesson study was "imagine hidden variables and relations by asking questions based on information presented in graphs and appreciate the significance of being able to analyse situations presented in graphs" (Gonzales, 2018). Communicating through emails and Skype, the lesson study teams of Malaysia and the Philippines collaboratively developed a lesson on energy which the teacher of each country taught simultaneously in their respective class through video conferencing using Skype. The lesson consisted of two tasks. The first task involved a graph showing the total oil supply in terms of indigenous and imported supply, of Malaysia and the Philippines. The second task involved a graph showing the total energy consumption considering all sources, of both countries. The graphs were based on the data from the APEC Energy Database. Both tasks required students to analyse and interpret the information presented in the graphs by applying their mathematical and statistical knowledge and skill.

During the lesson implementation, students from each country took turns in asking and responding to questions of students from the other country resulting in their better understanding and appreciation of how energy is consumed and conserved in the two countries as well as how wise use of resources and development of other local sources of energy can help sustain development.

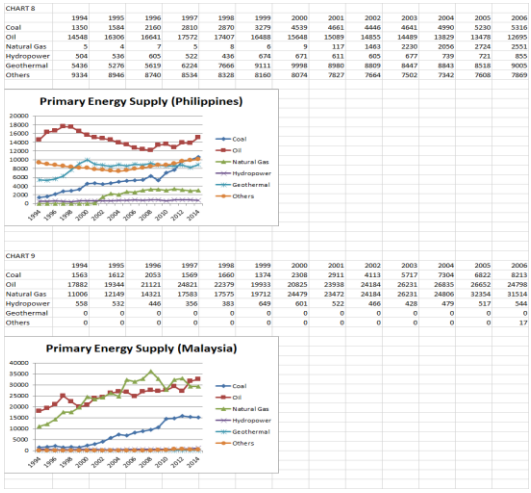

Figure 5. *Graphs on the primary energy supply of the Philippines and Malaysia from 1994 to 2014 were based on the APEC Energy*

Figure 6. *Filipino teacher listening to the discussion of the students (The Malaysian class can be seen on the right screen.)*

The two examples cited show that due to the availability of digital technologies, constraints in finances, time, and distance are no longer hindrances for teachers, and even their students, to interact, share, and collaborate. The second example also shows how large amounts of data available online can be used to teach students statistical reasoning.

Another competence in communication and collaboration is netiquette (short for internet etiquette), a code of "good behaviour" on the internet (TechTerms 2017). Correct and proper online communication should be based on values and traits such as honesty, reliability, accountability, respect, discreetness, good judgment, keeping confidences, sensitivity, clarity, and conciseness. As already mentioned, sources of ideas should be duly acknowledged.

Digital Content Creation: In relation to digital content, this competence includes developing, integrating, and programming (School Education Gateway, retrieved on 12 February 2020). The succeeding discussion on ***Problem Solving*** will include programming.

As earlier mentioned in information and data literacy, teachers can integrate resources on the web into their lessons depending on their purpose. Besides this, teachers can develop digital content such as podcasts, e-books, and programs and also integrate existing digital content to the ones that they are developing. Activities like these are consistent with PPST's Curriculum and Planning domain in which proficient teachers are expected to "select, develop, organise and use appropriate teaching and learning resources, including ICT, to address learning goals."

An example of podcasts found in UP Diliman's College of Mass Communication website is UP NISMED's Go Teacher Go! radio programme's episodes aired over UP's community radio. School teachers are the programme's discussants most of the time. They discuss activities, lessons, or teaching strategies that can enable students to understand better a particular topic and address students' common difficulties and misconceptions in science and mathematics.

The author together with a science education specialist of UP NISMED created an interactive e-book using a d-book on Understanding Earthquakes based on a mathematics research lesson that used science as a context. They developed the lesson collaboratively with a group of high school mathematics teachers through lesson study. It is uploaded on the websites of the Center for Research on International Cooperation in Educational Development (CRICED) of the University of Tsukuba and UP NISMED.

Problem Solving: This includes the creative use of digital technologies (School Education Gateway, retrieved on 12 February 2020).

There are real-life problems that may be solved using digital technologies. Following are some examples. For identifying the route that avoids heavy traffic, drivers use the Waze app on their mobile phones. When abroad, so as to avoid getting lost, a foreigner can use Google maps on his mobile phone. Instead of wasting time waiting for a taxi to pass by a street, one can simply stay where he/she is and just book a Grab Taxi and be informed about the taxi fare, the amount of time that a taxi within the vicinity will fetch him/her, and the amount of time that the taxi will reach the destination. Then he/she can just go to the pick-up point when the taxi arrives. To avoid long queues, one can shop online. To avoid rushing, one can do online flight check-in. To save time in searching for relevant journal articles for research, one only has to encode the keywords in Google search for a host of choices to come out.

Creative use of computers, digital technology, is problem solving. In making a computer solve problems, one has to engage in computational thinking. According to Jeanette Wing, a computer scientist, "computational thinking is the thought processes involved in formulating a problem and expressing its solution(s) in such a way that a computer – human or machine – can effectively carry it out" (Wing, in Araya et al, 2019). To know what computational thinking entails, one has to be familiar with its elements which consist of concepts and practices (Grover and Pea, 2017). The concepts include logic and logical thinking, algorithms and algorithmic thinking, patterns and pattern recognition, abstraction and generalisation, evaluation, and automation. The practices include problem decomposition, creating computational artefacts, testing and debugging, iterative refinement (incremental development), and collaboration and creativity. Mathematics content and mathematical processes which are problem solving, reasoning, connection, communication, and representation involve most of these concepts and practices. Hence, computational thinking can be developed in mathematics teaching and learning. Engaging in computational thinking is consistent with the PPST's Content Knowledge and Pedagogy domain specifically the expectation from highly proficient teachers to "develop and apply effective teaching strategies to promote critical and creative thinking, as well as other higher-order thinking skills."

According to Grover and Pea (2017), programming is an especially useful platform for teaching computational thinking since it brings together several of the elements – both concepts and practices – that are central to computational thinking.

On 3 February 2020, the author was one of the observers of the results of the efforts of a group of teachers in Cavite National Science High School in relation to their Project PRISM (Promoting Robotics Integration in Science and Mathematics). This was their entry in the DOST-SEI's InnoBox Project which is a search for the most innovative teaching and learning resources that can be used in teaching both science and mathematics. In particular, their problem was how to show to the students of a grade 7 Science class what velocity and

acceleration mean, among others. So the teachers programmed the robots which are in the form of cars to solve the problem. The cars' casings were produced using the school's 3D printer. The outdoor activities involving the robots that the students performed generated data on time, position, and distance which were used as a basis for determining speed, velocity, and acceleration that the students later represented visually using graphs. Besides their excitement in performing the hands-on activity, the connection between the physical meaning and the visual representation of speed, velocity and acceleration became clear to the students. This innovative approach in teaching velocity and acceleration was collaboratively conceptualised by two Research teachers, one of whom is the Robotics Club adviser, and a Science teacher.

Figure 7. *The robots in the form of cars used in the Project Promoting Robotics Integration in Science and Mathematics*

Figure 8. *A student presenting the results of their group activity using graphs*

Figure 9. *Students gathering data generated by the moving robot*

In the school's Robotics Club where interested students are taught to program robots, some members have become better programmers than their Club adviser. They also have been participating and winning in local and international competitions. Inspired by this achievement, the local DepEd officials plan to train teachers of other public high schools in the place on robotics with the teachers in Project PRISM as trainers using the materials that they have developed. When this plan is actualised, then based on PPST's Domain on Curriculum and Planning, the group of teachers may be considered as distinguished teachers who "model exemplary skills and lead colleagues in the development and evaluation of teaching and learning resources, including ICT, for use within and beyond the school."

Conclusion

IR 4.0 necessitates digital competence in terms of information and data literacy, communication and collaboration, digital content creation, and problem solving. In order to facilitate the development of digital competence among students, teachers themselves must be digitally competent. By meeting the standards set forth in the PPST for the different stages of their career with the areas of digital competence as context as they relate to the different domains of PPST, teachers' digital competence can be developed. These domains are Content Knowledge and Pedagogy, Learning Environments, Diversity of Learners, Curriculum and Planning, and Personal Growth and Personal Development. Thus, digital competence can be considered as an integral part of teacher professionalism.

Developing their own digital competence can be embedded in teachers' regular practices such as preparing and teaching lessons. Guided by a research theme, teachers' engagement in lesson study can help them to be digitally competent as they collaborate in designing and implementing lessons, and reflecting on what they have learned about student thinking and learning through those lessons.

Problem solving is definitely prevalent in IR 4.0. Being anchored on problem solving, developing computational thinking is necessary for digital competence.

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Artificial Intelligence (AI) Teacher Education in Korea

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Abstract

Artificial Intelligence (AI) is one of the important concepts in our current society in the 4th industrial revolution period. It is the core technology in the "virtual physical system" which connects machines and humans intelligently. AI is also a hot issue in education. Beyond academic discussions on how much AI-related education should be taught, curricula and textbooks are actually being developed to teach AI content in school education. This paper introduces new challenges on AI education and AI-related coding education initiated by Korean educational society during the current decade and the new policy to train "AI teachers" currently proposed by the Korean government. This paper presents three AI-related teacher training programmes the Korea National University of Education has provided based on the new challenges of Korean society.

Keywords: AI, teacher education, Industrial Revolution 4.0

Introduction

The 4th Industrial Revolution is a period when the productivity of work is dramatically improved as the whole process of production, distribution, and consumption of goods or services become more intelligent by AI systems that interpret data, learn information and utilise learning to solve specific goals and tasks. AI is one of the important key concepts in our society for educated people to develop sustainably the new intellectual society based on the highly sophisticated technologies like IoT, Virtual Reality, and autonomous driving vehicle which are the basis of the Fourth Industrial Revolution

AI has two concepts. The first one is *AI as a system* equipped with various high-tech machines used in the current society like industry, court, hospital, and school. AI is a machine system to implement a variety of recognition, thinking, and learning activities that have been performed by only human intelligence. For example, an autonomous driving vehicle is a car equipped with AI which can recognise or treat quickly various environmental information collected through high speed 5G network and make a decision for driving autonomously and safely. And, in the near future, we could see AI math teachers, who never give up and explain well to students struggling with math at school. An AI robot helps students study math to their heart's content. AI has a human attribute to make machines to act like a human being and to model human intelligence to solve various problems.

The other is *AI as contents* to make *AI as a system* work efficiently. Machine learning and deep learning are typical examples. They allow machines to analyse and process data and

information that humans need. To understand concepts of machine learning and deep learning students need to know a huge amount of knowledge on mathematics, statistics, computer languages like Python and R, and problem-solving techniques like Nearest Neighbours and Naive Bayes. Schools are obliged to teach students gradually and systematically these knowledge and strategies developed so far. Furthermore, from now on, schools must educate in advance the advantages and limitations of the new world in which AI emerges as well as the ethical aspects of the world's members in common, which is absolutely necessary to create an environment in which machines and humans can coexist and communicate well.

Why AI learning in school is important?

Why AI should be learned in school? Many people might claim that it is enough for high-level experts only to need to know about AI even if we admit that it is very important in our society. The reasons why various AI techniques should be taught in schools can be discussed from the following four perspectives by Kliebard (2004):

- Humanistic perspective: AI is a human heritage. It is like the Pythagorean Theorem. Why all students must learn the Pythagorean Theorem? It is useful in real life, but it needs to be left to future generations in itself as a beautiful theorem discovered by humans. Research on AI began in the 1950s by and many kinds of AI skills have been developed. Students need to understand the key skills that guide the rapid change of the modern period. Or at least, students need to learn the previous concepts to understand the AI skills systematically as early as possible.
- Ordinary life perspective: AI is closely related to our daily lives. AI to help human activities already exists next to us. Students need to learn about the benefits and limitations of AI in our lives and the ethical aspects that arise from the use of AI in order to better lead their daily lives.
- Developmental perspective: AI is a problem-solving strategy. Students can develop their own thinking power by exploring the basic AI technique needed in solving various real-world problems.
- Social developmental perspective: AI is changing the current society as well as will change our future society. Students have to learn AI technology to speed up the development of workstations where they will contribute as workers after graduation from school. Schools need to provide a proper high level of AI techniques for students who will lead our next society which will belong to the 5th industrial revolution era.

New challenges in education

In the new society, AI as a system equipped with robots are in charge of many things that human beings have done so far, and new content like machine learning techniques that have not been taught or emphasized so far in school is introduced. Education demands new challenges that are quite different from what we have seen so far. In Korea, AI and AI-related coding schools have long been popular in the private education market and various high

school AI textbook are being developed for public education to absorb this interest for private education (Lee, Im, Jang, Song, Kong, Park, 2020; Youn, Kim, Nam, Choi, Jung, Kim, 2020).

In addition to teaching students' new contents like how to understand and utilise well AI itself as well as the various techniques used in machine learning, schools need to teach the connection among curricular rather than a lot of fragmentary knowledge and the complex relationship between AI and human in which technology changes human ways of thinking and living. For example, the school needs to emphasize new kinds of statistics using big realistic data rather than fossilized knowledge and calculations for a given table and figure. Furthermore, as AI technology changes, education should develop soft skills for super-intelligent society, such as sociality, sensitivity, empathy, a challenge to adventure, and networking, as well as the ability of critical thinking and problem solving related to the use of technology.

Prior to conducting AI education, as part of efforts to improve the educational environment, the Korean government announced the SMART education policy that curriculum, teaching, and learning methodology should become selective, integrative, and custom-made education, which is "self-directed, motivated, adaptive, resource-enriched, and technology-embedded" (Ministry of Education, 2011, 2012, 2015). And, in a similar context, the Korean government also announced the "software education" policy to secure national competitiveness in a software-driven society in which software is central to innovation, growth, and value creation by preparing for a future society through software education (Ministry of Education, 2016).

The new challenge of teacher education

In 2016, the South Korean MOE announced that from 2018, all elementary school pre-service teachers at 11 teacher education universities were required to provide "software education" focusing on coding education with an interdisciplinary approach in order to prepare for mandatory software education in elementary schools which started in 2019 (Ministry of Education, 2016).

Furthermore, in 2019 the South Korean government decided to train the so-called "AI teachers" who are responsible for fostering new human resources to lead the new era of the fourth industrial revolution. Each year for five years, 1,000 AI teachers will receive master's degrees through three years of in-service training at the universities of their choice from the second semester of 2020. The government will support half of the tuition for in-service teachers during a three-year master's course. Convergence will be at the heart of educational methods.

The new challenge of Korea National University of Education

As the only comprehensive teacher training institution in Korea, Korea National University of Education trains all teachers from kindergarten to high school and provides almost all kinds of job training programmes, and is responsible for the nation's new principal training and new senior teacher qualification programmes.

The university is also in charge of active leading roles in new kinds of AI teacher education and software education for teachers, recently proposed by the South Korean Ministry of Education. The university has the following innovative programmes in operation: AI Master Degree programme, Drone Flight Club with Python Coding, Entry Block Coding Course for Pre-service Elementary Teachers.

AI Master Degree programme

KNUE will train about 160 in-service teachers every year from this year. This is one-six of the nation's whole quota of 1000. The university will urgently hire two AI professors this semester and secure facilities and space for the in-service teachers to practice on weekends and after school and furthermore will receive manpower support from the University of Science and Technology, which is one of the top universities in a science area and located near KNUE campus. And, curriculum development is currently underway with the aim of announcing it by the end of the year (KNUE, December 2020).

According to the draft version of the curriculum, the curriculum is divided into compulsory, optional, and independent study. Table 1 shows the curriculum structure and Table 2 shows the goals of the curriculum subjects. For the compulsory, total of 18 credits including 12 credits of AI programming skills and AI basic knowledge in the first year and six credits of AI and education and AI Ethics and Education in School in the second year are charged. In the 2nd year, students choose one course in one semester as an elective course. In the 3rd year, students have to choose Project in Major and Independent Study II in the first semester and Independent Study III to complete a thesis in the second semester.

The Programme has already started in September 2020, but practical attendance classes will begin from this winter vacation period in January 2021 because all the students are in-service teachers. Although the final version of the curriculum will appear in December 2020, the following considerable problems are being raised:

A Characteristic of the Programme: Originally, the program was launched with the goal of convergence education related to AI. It was not just to introduce engineering knowledge or programming techniques to school teachers, but to develop a convergent eye to teach their subjects through AI. It is pointed out that too many compulsory subjects are provided in terms of AI-related technical courses, making it difficult to achieve the educational goal. The success of the programme depends on how well an AI-related convergence curriculum can be designed.

Diversity of Students' Major Background: Because each student has his or her own major subjects, there is a great deal of difference in students' mathematical knowledge and programming skills, which are very critical in AI education. There should be at least four tracks students will choose by their own majors: Tracks for elementary teachers, track for humanity major teachers, tracks for a science major teachers, and track for music and art major teachers

Budget and Lack of Experience: In order for this programme to succeed, manpower, facility, and space must be effectively provided in a timely manner. If 160 students enter the school every year, about 500 students will stay on campus within three years. To do this, a sufficient budget must be secured. Another obstacle in managing the programme is the lack of prior experience, both at home and abroad. It is urgent to establish a system in which one country's operational experience is shared quickly with another country to get feedback from each other.

Table 1. *Curriculum Structure of the AI Convergence Major of KNUE (Draft)*

Category		Pts	1st year		2nd year		3rd year	
			1st sem	2nd sem	1st sem	2nd sem	1st sem	2nd sem
Compulsory	General	3			AI and Education			
	Basic	6	AI Programming I	AI Programming II				
	Advanced	9	AI I	AI II		AI Ethics and Education in School		
Selective	Basic	9				AI and Customized Instructional Design		
	Advanced				• Seminar in AI Edu-tech • Case Study of AI-based Science Education • Introduction to Machine Learning • AI and Art Education • AI and Mathematics I • AI and Elementary Education I • Analysis and Application of Big Data • Basic Statistics • AI and Computer Language I	• Development of AI-based Teaching-learning Materials in Science Education • Application of Machine Learning • AI and Mathematics II • AI and Elementary Education II • AI and Computer Language II	Projects in Major	
Common	Research	3				Individual Research (IR) I	IR II	IR III Thesis

Table 2. *Subject title and Objectives of the AI Convergence Major of KNUE (Draft)*

Subject Title	Learning Goals
AI and Education	Understanding of the technology, social and educational characteristics of AI, this course learns the history, characteristics, and effects of AI used in education
AI Programming I	This course learns coding and AI concepts using platforms developed for an AI education like Teachable Machine, Machine Learning for Kids, Entry
AI Programming II	This course learns AI-based coding and the process of controlling the physical environment using platforms developed for an AI education
AI and Customized Instructional Design	This course learns how to design customized classes which can be conducted by combining cognitive, emotional, and technical characteristics of students through AI data-based learning analysis.
AI Ethics and Education in School	This course learns interaction and association between humans and AI with an academic approach.
AI I	This course learns how to implement the basic machine learning algorithm using Python and understanding the core techniques of machine learning and deep learning.
AI II	This course learns how to understand and implement various algorithms of machine learning and deep learning and how to use Arduino or Raspberry Pi as teaching tools for the convergence education related to machine learning
Seminar in AI Edu-tech	This course learns AI Edu-tech products that contribute not only to the private education market but also to public education, and how to develop the ability to apply them to design AI-based teaching materials and platforms.
Case Study of AI-based Science Education	This course learns how to apply AI to science classes. Based on the pre-research literature that applied AI to the curriculum, it investigates how to develop teaching and learning materials, and evaluation methods to embody the characteristics of AI-based classes.
Development of AI-based Teaching & Learning Materials in Science Education	Understanding the AI techniques, this course learns how to foster the ability to apply them to science education.
Introduction to Machine Learning	This course learns basic machine learning techniques like Nearest Neighbors and Naive Bayes through R.
Application of Machine Learning	This course learns machine learning techniques at a higher level with actual data.

AI and Mathematics	This course learns the fundamental level of mathematics for understanding, implementing, and designing AI models including calculus, statistics, linear algebra, discrete mathematics
AI and Art Education	This course learns the aspects of contemporary art using AI and ways to use AI technology for art education.
AI and Statistics	This course learns the fundamental level of statistics for understanding, implementing, and designing AI models
Analysis and Application of Big Data	This course learns how to analyse realistic big data in everyday life using R and Python and learns how to apply various real-world examples.
AI and Elementary Education I	This course learns AI techniques and AI-based education models that can be applied to elementary school curriculum education.
AI and Elementary Education II	This course learns how to design AI-based classes that can be applied to primary curriculum education.
Individual Research	Individual Research I, II, III

Drone Flight Club with “Python” Coding

The drone is recognised as one of the AI-related technologies driving the fourth industrial revolution. There were various attempts to secure the capabilities needed in the era of the fourth industrial revolution by introducing drone control skills such as simple manipulation by radio. But it was difficult to expect educational effects as their competency. KNUE decided to foster the problem-solving capabilities of its pre-service teachers by providing drone experience controlled through programming.

As the first step, KNUE made Drone Club for the pre-service teacher to enjoy a Drone flying experience through coding of Python. However, most of all the first members of the club came from the Department of Computer education. It is because many students thought that learning Python might not be easy. We expect more students to come from various departments. It might be possible now because we teach Python in high school under that current curriculum.

“Entry” Block Coding Courses for Pre-service Elementary Teachers

ENTRY is South Korea's programming language platform developed by the Entry Education Research Institute. It is a main block-based language used officially in Korea for elementary and junior high school students. (Visit play-entry.org to provide an English version for learning, creating, and sharing).

The goals for providing ENTRY coding education to elementary school pre-service teachers are as follows.

- Securing the software education leadership capacity of elementary school teachers in preparation for the mandatory software education of the 2015 revised curriculum

- Reinforcement of the teaching ability of elementary school teachers to foster creative and interdisciplinary talents of students pursued by the 2015 revision of the curriculum.
- Strengthening the creative and logical thinking power of elementary school teachers by improving their computing power

Table 3. *Curriculum Structure of Coding Course for Pre-service Elementary Teachers*

Student Major	Course Title
Courses for All Elementary Students	• Elementary Software Education and Computational Thinking *(Basic level coding)*: Grade 1 • Software Education in Elementary Education *(Middle level coding):* Grade 2
Courses for Elementary Computer Education Major (High level coding)	• S/W and Problem Solving: Grade 3 • Creative Computing Thinking: grade 3 • S/W and Ordinary life: grade 4 • Multimedia and S/W: grade 4
Courses for Elementary Subjects Major (High level coding)	Choosing One course with 3 credits during Grade 3 and 4 according to their major: Korean Language, Mathematics, Social Study, Technology, Art, Music, and Science

Conclusion

The 4th industrial revolution is a current industrial change based on a “virtual physical system” that connects machines or robots and human intelligently through a high-speed network 5G. AI is the core technology in the system. The most important key competencies for operating the system are to understand AI itself and computational thinking to enable human to communicate with a machine. It is a hot issue in the Korean educational community like in many countries. It is essential for the sustainable development of the 4th industrial revolution.

AI is posing enormous challenges to the nation's educational society and teacher training institutions. Korea decided to introduce software education or coding to the national curriculum from the 5th and 6th grades as compulsory from 2018 and then, launch a software teacher education and an AI teacher education programme. Many people worry that it might be a hasty decision made without a curriculum or faculty and facilities, but many others believe that it is an understandable decision because AI teacher education is too urgent to take place after sufficient preparations are made. No one can predict success, but Korea's new attempt is believed to be a good touchstone for SEAMEO countries regardless of whether it is successful or not.

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Looking Back on the 12-year APEC Lesson Study Project: Thailand Perspective

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Abstract

In 2005, under the Ministry of Education, Thailand, the Centre for Research in Mathematics Education (CRME) produced a proposal titled "A Collaborative Study on Innovations for Teaching and Learning Mathematics in Different Cultures among the APEC Member Economies" (HRD 03/2005) to APEC Human Resources Development Working Group (HRDWG) at Pattaya, Thailand, thus setting up international cooperation in education. In this proposal, the Center for Research on International Cooperation in Educational Development (CRICED), the University of Tsukuba Japan, jointly focused on the necessity for teaching innovations through Lesson Study. This paper aims to review the APEC Lesson Study Project (2005-2018) proposed by Thailand and Japan from Thailand's perspective. The project from the Thailand perspective was mainly managed by the Center for Research in Mathematics Education, Institute for Research and Development in Teaching Profession for ASEAN, Khon Kaen University.

Keywords: Lesson Study, open approach, APEC, curriculum, learning community

Background for the APEC project in Thailand

The idea for Asia-Pacific Economic Cooperation (APEC) Lesson Study Project was initiated when the Ministry of Education, Thailand, launched the initial educational reformation in 1999. The reformation mainly focused on the learning process as the central issue to be resolved. As a result, a revised core basic Education Curriculum was introduced by the Thailand Ministry of Education in response to the educational reformation. The integration of three major components of content, process/skills, and character were highly emphasized and considered as the major change in the revised core basic Education Curriculum. Following this line of reasoning, enhancing educational quality through curriculum implementation became the issue for seeking teaching innovations. Khon Kaen University as a leading higher education institution launched a long-term project entitled "The 30 years Khon Kaen University (2000 to 2030)" to respond to the demand.

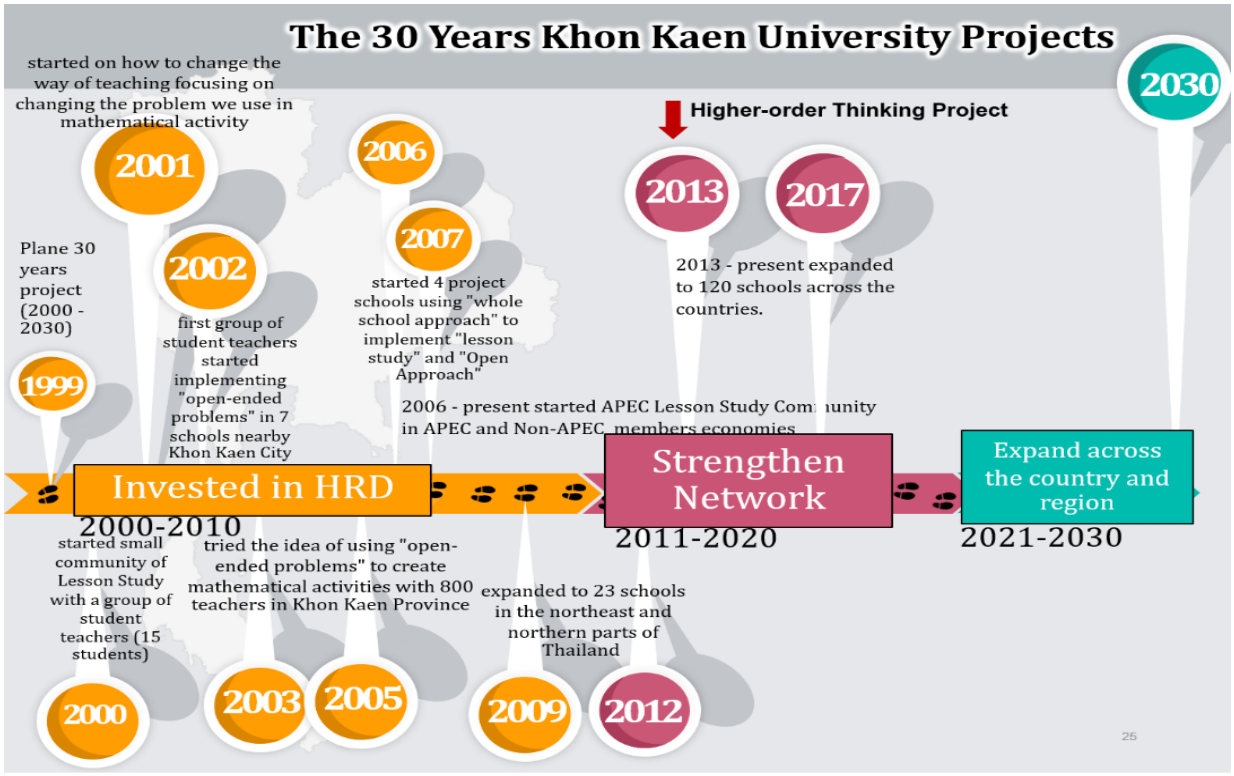

Figure 1: *The 30 years Khon Kaen University project, 2000-2030 (Inprasitha, 2011)*

As shown in the above diagram (Figure 1), the 30 years Khon Kaen University (2000 to 2030) project consists of three phases with each phase taking 10 years to complete. The first phase project (2000-2010) of the project was mainly invested in human resource development by producing a new generation of graduate students in the mathematics education programme and at the same time preparing contexts for long-term implementation of innovation. This is followed by the second phase (2011-2020) which was planned to strengthen the networking, and the final phase (2021-2030) would be channelled into spreading the effects by expanding the teaching innovations, not only at the national level but also at the ASEAN regional level.

The 30 years Khon Kaen University project (2000-2030) was instigated by a progressive institutional development with the establishment of the Centre for Research in Mathematics Education (CRME) in 2003, followed by the Khon Kaen University of Excellence in 2004, and the Research Unit in Mathematics Education as a part of National Center of Excellence in Mathematics. Meanwhile, a new master's degree programme in Mathematics Education was formed as a great platform for research and innovation development.

In 2004, the Open Approach innovation (Nohda, 2000 in English, 1983 in Japanese; Becker & Shimada, 1997 in English; Shimada, 1977 in Japanese), which was initiated from Shimada's related Japanese secondary school mathematics textbooks in the World War II, was adopted in the new paradigm of the 5-years Mathematics Education Teaching Professional programme of Faculty of Education, Khon Kaen University. This corresponds to the educational reformation by introducing innovative teaching professionalism.

Development of APEC Lesson Study Project

In 2005, under the Ministry of Education, Thailand, the CRME proposed a proposal titled "A Collaborative Study on Innovations for Teaching and Learning Mathematics in Different Cultures among the APEC Member Economies" (HRD 03/2005) to APEC HRDWG (Human Resources Development Working Group) at Pattaya, Thailand, thus setting up international cooperation in education. In this proposal, the Center for Research on International Cooperation in Educational Development (CRICED) and the University of Tsukuba, Japan, jointly focused on the necessity for teaching innovations through Lesson Study. Since the TIMSS Video Tape Study and other influences such as 'Before it's too late' in the USA (National Commission on Mathematics and Science Teaching for the 21st Century, 2000), Japanese Lesson Study was already a world reform issue for professional development of teachers for a student centred approach and the establishment of the school for learning community, so called school-based lesson study. Thus, surveying the Japanese Lesson Study was a major component of the proposal. The Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan, became a co-proposal economy from the 2006 proposal. The CRME and the CRICED have implemented four series of APEC projects collaboratively as follows:

1. First Series from 2006 to 2008: Innovative teaching mathematics through lesson study which includes mathematical thinking as for the theme and innovation of classroom tasks for the assessment.
2. Second Series from 2009 to 2011: Mathematics textbooks, e-textbooks, and educational tools.
3. Third Series from 2012 to 2014: Emergency Preparedness Education.
4. Fourth Series from 2015 to 2018: Cross-border Education and STEM Education.

Every year, the CRICED managed the planning meeting in Tokyo to promote the theme of Lesson Study while the CRME managed the report meeting in Khon Kaen. The theme of Lesson Study, as well as Lesson Study demonstrations which derived from both meetings, were included in the programmes. These four series of APEC HRDWG projects have successfully contributed to innovative educational practices in Thailand as well as the APEC member economies and the non-APEC member economies.

On top of that, the teaching approach for developing mathematical thinking skills has been promoted to APEC member economies. For example, Japanese primary school textbooks ''Study with your friends: Mathematics for Elementary School' published by Gakko Tosho in 2005 and 2011 written by the teachers of the Elementary School attached to the University of Tsukuba, which is school textbooks to develop mathematical thinking by using what students already learned, had been translated into English and used for reference books for the Lesson Study projects in several economies for learning Japanese Problem Solving Approach to develop mathematical thinking in the classroom. In addition, these have been adapted into several languages in APEC economies for teacher education textbooks in Thailand, Mexico, and Papua New Guinea based on their necessity under their culture in education. Most of them have been functioning as national textbooks to develop thinking skills. Eventually, curriculum Standard for Mathematics (SEA-BES, CCRLS, 2017) on ASEAN countries also included mathematical thinking in their framework (Mangao, et.al, 2017). Further achievements of the APEC Lesson Study project can be seen such as Isoda and Katagiri (2012), Inprasitha, et al. (2015), Cabinet of Japan (2017), Isoda and Olfos (2021), and so on. These became a foundation for the fifth series (2019-2021) of APEC HRDWG, which is

considered a timely response to the demanding skills in the Digital Era for the 4th Industrial Revolution.

The Impacts of APEC Lesson Study Project on Thailand's Educational Practices

The APEC Lesson Study Project was started in 2006 until to date. In the first stage of the APEC Project, Lesson Study has been implemented through the internship programme of the Khon Kaen University and collaborative schools. The Thai edition of the textbooks was developed with the support of Isoda and the mathematics teachers of Elementary School attached to the University of Tsukuba, In Thailand, on demand of CRME, they provided several lectures and lesson study demonstrations to illustrate the content knowledge and the pedagogical content knowledge which were embedded in the textbooks. The lectures included the necessary knowledge for teaching multiplication in Isoda &Olfos (2021) and mathematical thinking in Isoda and Katagiri (2021) for developing children who learn mathematics by and for themselves.

The textbooks 'Study with your friends: Mathematics for Elementary School' published by Gakko Tosho in 2005 were originally developed for the Problem Solving Approach under the Japanese Curriculum Policy to develop students who learn mathematics by and for themselves. The CRME needed the adaptation to the Thai Curriculum on the name of Open Approach as for their method of teaching. Learned Ph.D. Programme students at Khon Kaen University, as well as the CRME staff, supported the implementation of the Open Approach at schools by using the textbooks for the Problem Solving Approach. After Khon Kaen University's Ph.D. students took the positions for teacher education, the Lesson Study for Open Approach widely spread to the whole of Thailand based on their experience at their graduate programme. Because most of the students got their Ph.D. concerning Lesson Study and the Open Approach, they became specialists to implement these two innovations.

The Whole School Approach was introduced by Inprasitha (2006) after making the necessary modifications to suit the context of Thailand. The Whole School Approach is a 'new teaching approach' of school-based approach by integrating 'Open Approach' in the Lesson Study process as a method for improving teaching practices.

The exposure of Lesson Study and Open Approach innovations was significantly expanded to the northeast and across the country in Thailand through the collaboration between CRME, Khon Kaen University since 2006. Ultimately, this leads to the establishment of the Institute for Research and Development in Teaching Profession (IRDTP) in ASEAN, Khon Kaen University in order to enhance and sustain the results of Lesson Study and Open Approach innovative development up to national and international levels. Currently, the APEC Lesson Study project has successfully covered schools in 33 provinces located in northeastern, central, south, and southern border regions of Thailand with the respective 20, 4, 6, and 3 provinces. With the high commitment from higher education institutions, particularly Khon Kaen University has made a great success to form strong networking consists of a total of 250 schools from various regions. As a result, the strong networking with the university experts' assistance would ease the problems of teaching and learning process in daily educational practices and teachers' professional development would be enhanced too.

Figure 2: *Weekly Cycle of Lesson Study Process (Inprasitha 2011)*

On the current ongoing project at the IRDTP, the following procedures are the policy for expansion:

1. The dissemination of Lesson Study themes and their process was introduced to the project schools in various provinces of Thailand. Because of the requirement of Lesson Study, the creation of a learning community through the Professional Learning Community (PLC) was formed.
2. Continuing collaboration between CRICED and CRME, IRDTP on professional development base on Lesson Study and Open Approach, developing textbooks to enhance thinking skills for the 21st century.
3. The collaborative team, comprised of IRDTP, Khon Kaen University, Teacher Council of Thailand, National Institute for School Teachers and Staff Development (NITS) of Japan, and Institute of Professional Development of Teachers, and Teachers and Educational Personnel, have been working together in preparing Educational Professional Development Programme. This programme aims to enhance the capabilities of school administrators and supervisors in promoting quality of classroom management and leadership thus creating a network for educational professional development between educational agencies in Thailand and Japan. Practical training is expected to upgrade the quality of educational practices through the institutional linking policy. This kind of institutional collaboration can prepare and develop a better teaching profession for a more promising future.
4. Collaboration between IRDTP, University of Tsukuba, and SEAMEO to promote the SEA-Teacher Project to provide opportunity for pre-service student teachers to have experiences in schools in other countries in Southeast Asia.

Further Challenges for Lesson Study

Under APEC, the link between the University of Tsukuba under MEXT Japan and Khon Kaen University under the Ministry of Education of Thailand have conducted collaboratively in the two respective projects, namely "The Inclusive Mathematics for Sustainability in a Digital Economy" (InMside I) in 2019 and "Informatics and Data Science Education Reform for Digital, Inclusive and Sustainable Society" (InMside II) in 2020. It is a challenge for us to conduct the two respective projects during the COVID-19 pandemic to the era of New Normal. InMiside I project is managed collaboratively with co-project overseer, Roberto Araya, the University of Chile on behalf of the Ministry of Education, Chile and InMiside II is collaborated with co-project overseer, Sofian Azumi bin Tajul Arus, Ministry of Education, Malaysia.

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