BECOMING LEADERS IN SUSTAINABILITY EDUCATION

A Handbook for Educators
ACKNOWLEDGEMENTS

This book would not have come together without a dedicated team striving for quality education in a sustainable world, from all over Asia. I would like to thank our diverse group of contributors, who graciously and openly shared their lesson and curriculum plans in this publication so others may be inspired to become leaders in sustainability education in their classrooms. I also extend my gratitude to our consultant editor, Dr Tricia Seow of the National Institute of Education, Singapore, for lending her wisdom and expertise in both education and sustainability. She has helped to focus the publication’s content and strategies to be relevant to every teacher wishing to implement education for sustainable development. Finally, I wish to thank the team at The HEAD Foundation, and specifically commend Hillary Loh and Linda Tay, for their tireless effort in putting the publication together and being instrumental in shaping the vision of this Making HEADway series, *Becoming Leaders in Sustainability Education*.

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PREFACE

Education for Sustainable Development (ESD) first came to public attention during the United Nation Conference on Environment and Development in Rio de Janeiro in 1992, which formally acknowledged the important role that education plays in “improving the capacity of the people to address environment and development issues”. Since then, ESD has gained wide acceptance in government and educational circles. ESD is multi-faceted and complex, encompassing economic, political, social, cultural and environmental dimensions of sustainable development, as reflected in the 17 Sustainable Development Goals put forward in the 2030 UN Agenda.

ESD requires educators to shoulder the challenging task of enhancing students’ understanding and competences for contributing to sustained economic viability, social inclusivity and justice, as well as safeguarding the environment.

ESD requires educators to shoulder the challenging task of enhancing students’ understanding and competences for contributing to sustained economic viability, social inclusivity and justice, as well as safeguarding the environment. Given its broad scope, no one subject teacher can teach all aspects of sustainable development, even though each teacher has the capacity and opportunity to teach about sustainable development within their classrooms. ESD is relevant to a broad spectrum of school subjects from geography and the sciences through to the humanities subjects like History, Social Studies and languages. In this 6th handbook in the Making HEADway series, we showcase how twenty-five educators from eight Asian countries teaching a range of subjects approach sustainable development within and across subjects.

As educators, we have to think carefully about our role within ESD. Do we teach students facts pertaining to sustainability only when it is relevant to our subjects? Or do we need to purposefully (re)design what we are teaching to ensure that sustainable development is core to what we teach in our classrooms? Is it enough to ensure students have the knowledge of sustainability, or should we as educators aim for behavioural change and action? Do we want them to change their behaviour and take action as part of our curriculum/lesson design, or do we just give them the tools to use in the future after they have left school? These questions are intertwined with questions of what we think the purpose of ESD is, which is still being hotly debated by researchers.

Moreover, how we respond to them at the school or classroom level would depend on our particular educational context and goals, curriculum structure and assessment priorities, and personal preference and readiness.

Putting this ambiguity aside, however, education research does provide some guidance for those of us who are concerned about the quality of sustainability education in our schools/classrooms. If you are reading this preface, it would be safe to assume you belong to this group!

First, it goes without saying that we have a duty to develop the knowledge students need to understand issues related to environmental, socio-political and economic sustainability. Education research also suggests that students learn better when they are actively engaged in the learning process — for instance, with inquiry-based learning or experiential or field-based learning. Researchers have found a positive link between outdoor experiences and gains in environmental knowledge. This approach to learning also has the potential to impact students affectively.

A recent study by researchers at the Sustainability Learning Lab (SLL) at the National Institute of Education, Singapore, found that students who participated in an inter-disciplinary outdoor experiential learning camp reported significant increases in their feelings of connection with nature, laying the foundation for future conservation efforts.

Designing authentic experiences that enable students to engage with concrete issues affecting their communities or personal lives, and creating opportunities for them to apply what they learn to these issues, are particularly useful to learning. This is because students perceive what they are learning as relevant, and this increases their motivation to learn. When students gain first-hand experience of how to take action to enhance sustainable development, it has the potential to provide them valuable skills and insights for their future roles as active and contributing citizens. For example, in the same SLL study, students reported that hands-on learning about work being done to conserve marine ecosystems gave them a sense of hope that degraded ecosystems can be restored.

Bearing both the questions confronting educators as well as the best practices from research in mind, this 6th handbook in the Making HEADway series focuses

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on sustainability education from the perspective of educators. The chapters in this book have been carefully curated to provide positive examples of how sustainability education has been carried out by educators in Asia, with the hope that their ideas can be adapted to your school/classroom, or serve as a springboard for new ideas in your curriculum and lesson planning.

The volume is divided into three sections and provide examples of good practices at different scales, within and across subject areas, and with varied goals with regard to taking action.

**Section 1** focuses on curriculum development for sustainable development with examples of cross-curricular integration. Some chapters also demonstrate how to integrate classroom-based lesson sequences with experiential and authentic learning outside the classroom. The examples span from primary/elementary levels of education through to teacher education, in diverse education systems in Bhutan, Indonesia and Japan.

**Section 2** provides examples of how to support sustainability education through the use of pedagogical strategies that encourage students to learn actively and mindfully. The chapters here showcase a range of strategies like gamification, inquiry-based learning, and technology-enhanced learning. Students communicate their understandings through a range of formats like debates, the use of technology, as well as in-class discussions. Though they span a gamut of content related to social and economic inequalities, economic growth, and environmental management, these chapters invite students to reflect on the links between the content learned and sustainable development, and/or consider the implications of what was learned to their own lives. Such tasks are important to the development of reflexive and engaged citizens.

Although taking action is implicit in many of the earlier sections, **Section 3** focuses on this key desired outcome of ESD — nurturing individuals who are willing and able to take concrete action to support sustainable development. The chapters provide positive examples of how we can purposefully involve students in the process of designing, implementing and/or developing solutions to the real-world problems observed in our communities. Education research has demonstrated that experiencing success in taking action for the environment, for example, is a key motivator for sustaining behavioural change and willingness to advocate for sustainable development. The examples here show clearly how educators have guided students to address diverse sustainability issues like waste disposal, reducing plastic use in everyday life, or sustainable agriculture. Hopefully, such lessons can spark a generation of citizens who can and will take action in support of sustainable development.

The journey of a thousand miles begins with one step. While ESD is a long-term process, involving many players (including educators like us), we do not need to be overwhelmed by this complexity. Instead, we can be hopeful and choose each day to educate our students positively. Each chapter in this series is a step in our ESD journey. The strides might differ in length, and the speeds might vary; but collectively, they show us how we can design, implement and take action for sustainable development. We enjoyed pulling this volume together and we hope you find some inspiration in these chapters!

Dr Tricia Seow
Co-chair of the Sustainability Learning Lab, National Institute of Education, Nanyang Technological University, Singapore

“While ESD is a long-term process, involving many players (including educators like us), we do not need to be overwhelmed by this complexity. Instead, we can be hopeful and choose each day to educate our students positively.”
CONTRIBUTORS’ BIOGRAPHIES

Mr Domingo S. Adolfo, Jr has been a teacher for more than five years now. He started teaching at De La Salle University Integrated School, teaching across levels in Junior High School for different academic years. These include academic subjects in Social Sciences: Asian History, World History, Economics, and Contemporary Issues. He graduated from the Philippine Normal University – Manila with a Bachelor of Secondary Education where he majored in Social Science with specialisation in Women Studies. Currently, he is the Academic Supervisor for Social Science in the Junior High School at De La Salle University Integrated School. His passion for teaching and professional development are evident with his participation in various seminars, training, conferences and workshops, which help advance his knowledge and pedagogy in teaching social science.

Mr John Brian S. Molina is a graduate of University of Santo Tomas, where he attained a Bachelor of Secondary Education majoring in Social Studies. He started his journey as a social science educator in the University of Santo Tomas where he taught both junior and senior high school students. Because of his enthusiasm and passion for teaching, he was tasked as one of the mentors of pre-service exchange student teachers from Southeast Asian Minister of Education Organization (SEAMEO) in 2019. Currently, he is teaching in the De La Salle University Integrated School. His love and interest in the field of Social Sciences led him to pursue his Master of Arts in History in the Graduate School of University of Santo Tomas. Apart from academia, he has served as a resource person in different programmes at GMA 7, one of the biggest TV networks in the Philippines, namely, Pinas Sarap and iJuander.

Ms Divine Mercy M. Go is a part of the Junior High School Faculty at De La Salle University Integrated School. She is currently teaching Asian History under the Social Science department. She completed her bachelor’s degree in Secondary Education at the Philippine Normal University majoring in History and is currently pursuing her master’s degree in Social Science Education at the same university. In her five years of professional experience, she has taught courses at the Senior High School for Humanities and Social Sciences, and also coached for a national competition in the Philippine Geography Olympiad. As a certified Apple Teacher and Microsoft Innovative Educator, she is equipped in integrating technology both in content and pedagogy.

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Ms Suwaida Lahama is an experienced Physics teacher who specialises in teaching Grade 11 students. She has been teaching since 2008 and currently holds the position of Head of STEM Education at Narathiwat School in Thailand. She earned her bachelor’s degree from Yala Rajabhat University.
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Ms Sayaka Matsukura is an English teacher at Inagakuen, a public junior high school in Saitama Prefecture, and a Ph.D student in Education at Sophia University. As the head of research, she oversaw developing teaching materials, conducting evaluation research, planning and organising teacher training for Global Citizenship Education, and has been involved in curriculum development for Global Citizenship Studies since 2015. As a board member of the NGO named DEAR (Development Education Association and Resource Center), she is also involved in the promotion of development education. She graduated from Sophia University with a master's degree in Education. Her current research focuses on the effects of ESD practices, including global citizenship education, on teachers’ growth and transformation and how schools and other organisations collaborate to promote ESD.

Dr Ho Huu Loc is an Assistant Professor of Water Engineering and Management at the Asian Institute of Technology (AIT). Before joining the institute, he was a Research Fellow at the Nanyang Environment and Water Research Institute (NEWRI) and the National Institute of Education (NIE) of Nanyang Technological University, Singapore. His professional experience in teaching, research and consultancy span over the last 10 years in Asia in the fields of Ecosystem Services, Nature-Based Solutions, Hydrology and Physical Geography. He has actively participated in multiple domains of pedagogy work and has demonstrated a keen interest in the integration of water management and nature-based solutions in the field of school education.
Ms Sreejita Banerjee is a doctoral student from India in Disaster Preparedness, Mitigation and Management at the Asian Institute of Technology (AIT). She attained her bachelor's and master's degrees in Geography, studying the role of landscape and the man-environment relationship from India. Besides her research experience, she has a diploma in Cambridge International Certificate in Teaching and Learning from the University of Cambridge. She has two years of work experience teaching Geography to high school students at a residential school in India. She believes in experiential learning and a holistic education that gives a wider perspective to the learners much beyond their curriculum.

Mr Hoang Minh “Thomas” Nguyen is a doctoral student from Vietnam in the Water Engineering and Management department at the Asian Institute of Technology (AIT). He received his bachelor's degree from University of Western Australia and masters from the University of Texas at Austin. Besides his research experience in Australia, United States and Vietnam, he has four years of experience teaching Environmental Science and Climate Change to classes of up to 120 students at the International University at Vietnam National University, Ho Chi Minh City. He likes to inspire students about climate change mitigation and adaptation, that it can be achieved at any level if everyone commits themselves to action wherever and whenever possible within their abilities.

Dr Thi Kinh Kieu is a senior teacher in the faculty of preschool education at University of Danang – University of Science and Education. She obtained her Ph.D at Kyoto University in March 2017. Her research is in training teachers on Education for Sustainable Development (ESD). Dr Kinh has more than 10 years of experience in training both pre-service and in-service teachers on ESD-related topics. She has published several articles about ESD teaching competences, involvement of NGOs in ESD, and campus sustainability. In order to enhance the teacher education institutions’ outreach, Dr Kinh founded a local NGO based in Da Nang City named Building Up Sustainability (BUS). The NGO helps to facilitate the partnership between teacher education institutions and local communities, including school teachers.

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Ms Ayuk Ratna Puspaningsih is a high school Biology teacher at SMA Negeri Bali Mandara from Bali, Indonesia. She has been teaching for 12 years in upper secondary level (15–17 years). She has contributed to developing the Biology learning goals for Indonesia’s national curriculum called Kurikulum Merdeka, is the author of student and teacher’s handbook, and is a curator for Biology teaching module for the Ministry of Education in Indonesia. She is currently a facilitator in the Guru Penggerak (Transformative Teacher) programme, where she is responsible for facilitating teachers’ comprehension of the programme. In addition, she is a speaker in the Sekolah Penggerak (Transformative School) programme, to facilitate participants that will become consultants of Sekolah Penggerak to comprehend the Kurikulum Merdeka. She has experience as a speaker in teacher professional development workshops for many different schools across the country.

Ms Ida Rahayu is a teacher at Green School Bali and a founder of Cita Bumi Rahayu Foundation, an NGO focusing on education and sustainability. She started learning about Permaculture in 2016 and became passionate about practising it in her lifestyle and sharing it with her students as well as other schools in Bali. She founded the Seeds to Table programme and brought it into local schools where education on sustainability is much needed. Seeds to Table is an educational platform that provides the solutions to waste problems, unsustainable food production and unhealthy diets. She co-authored the book *New Paradigm of Education Rising* launched in January 2023, currently one of the best-selling books in the educational category.

Ms Marsaria Primadonna (Pima) has been an educator for almost 20 years. Her passion is always about teaching and learning in an engaging, fun and inquiry-driven way. She believes that with technology and multimedia, learning can be brought to life in the classroom so students can gain deeper and more meaningful learning. As a local educational consultant for the Island Foundation, she is looking forward to extending her expertise in education for sustainability.

Ms Ida Rahayu

Ms Ayuk Ratna Puspaningsih

Ms Marsaria Primadonna (Pima)

Mr Agus Suprianto (Gontor) is originally from Bintan, Riau Islands. He has been working with the Island Foundation for over 10 years, beginning as Assistant Learning Facilitator and now as Learning Centre Program Manager. He is a passionate educator and a committed mentor for children living in small islands and coastal communities. He is currently completing his bachelor’s in Educational Technology.

Dr Tricia Seow is the Assistant Head of the Humanities and Social Studies Academic Group (HSSE) and co-chair of the Sustainability Learning Lab at the National Institute of Education (NIE), Singapore. She is the Programme Leader for the Master of Arts in Humanities Education programme, and leads HSSE’s Professional Development programmes. She is a Geography educator with 25 years of teaching experience in Singapore and overseas, and is especially interested in the signature pedagogies that support sustainability and environmental education. To this end, she has actively conducted research in field and classroom-based inquiry learning and place-based learning, in engaging students in discussions around environmental data, and in teachers’ practices in environmental and sustainability education.
Developing curricula for sustainable development

In this section, we focus on the question of what students should learn in Education for Sustainable Development (ESD), as well as how to sequence this learning. ESD, being broad in nature, is difficult to pinpoint in content since it can be approached from a plethora of subjects. Indeed, no one subject has a monopoly on ESD, though some — like Geography and Science — certainly lend themselves more easily to it. In fact, it is often suggested that ESD requires an inter-disciplinary approach, so as to shed light on sustainability issues from different angles, and to find solutions by drawing on the strengths and perspectives of different disciplines.

In this section, we showcase examples of inter-disciplinary curricula for ESD. For instance, in Chapter 1.3, we see students applying knowledge of permaculture and nutrition to an entrepreneurial school-based business in Ms Ida Rahayu’s Seeds to Table programme in the Green School in Bali, Indonesia. In Chapter 1.4, Mr Thinley Wangchuk describes the inter-disciplinary principles behind the Bhutan Baccalaureate (BB) programme, before going on to describe how these principles apply to the topic of environmental sustainability at Samtse College of Education. Pre-service teachers in Geography, History and English utilise their specialist subject knowledge to explore different dimensions of environmental sustainability in their community.

For ESD curricula to work, there needs to be a systematic framework around which the diverse content can be organised and sequenced. In Chapter 1.1, Ms Marsaria Primadonna and Mr Agus Suprianto from the Island Foundation in Bintan, Indonesia take primary level students through what is essentially an inquiry-based learning (IBL) approach of engagement, exploration, application and reflection in the Learning for Sustainability Framework. The authors provide lesson plans for each stage on the topic of human-made floods to illustrate how a single topic is taught consistently through the framework. A similar IBL strategy can be seen in Chapter 1.2 where Ms Sayaka Matsukura from Inagakuen Junior High School in Saitama Prefecture takes students through two cycles of inquiry in her spiral curriculum framework. The first inquiry cycle helps establish students’ understanding of the Sustainable Development Goals (SDGs) in their own voice, before a second cycle deepens this understanding by engaging students in a carefully scaffolded research project of their choice.

All the curricula highlighted in this section also feature a concern with cultivating a sense of personal efficacy in their students, over and above just the knowledge and skills related to sustainable development. Knowing how to act is a key motivator to becoming engaged and responsible citizens who are willing to work for the betterment of their communities. Our educators achieve this through engaging students with real world, community-based experiences and issues as part of the learning process.
The Island Foundation is a non-profit organisation established in 2010 with a mission to improve learning opportunities for children in Indonesia’s Bintan Regency in the Riau Islands. Its efforts focus on establishing local learning centres for students to attend after school, and it engages in local teacher training and community outreach. Its unique primary-level programme incorporates learning for sustainability and, since its inception, has impacted more than 3,000 students and trained more than 1,500 teachers. In the unit “Me and My Earth”, Ms Pima and Mr Gontor lead students through the effects of human-induced floods from improper waste management, and guide students on ways they can take action to prevent this in their community.

1.1 Educating for disaster-readiness
Ms Marsaria Primadonna & Mr Agus Suprianto

The Island Foundation is a non-profit organisation established in 2010 with a mission to improve learning opportunities for children in Indonesia’s Bintan Regency in the Riau Islands. Its efforts focus on establishing local learning centres for students to attend after school, and it engages in local teacher training and community outreach. Its unique primary-level programme incorporates learning for sustainability and, since its inception, has impacted more than 3,000 students and trained more than 1,500 teachers. In the unit “Me and My Earth”, Ms Pima and Mr Gontor lead students through the effects of human-induced floods from improper waste management, and guide students on ways they can take action to prevent this in their community.

In this chapter, we learn:
- How the Island Foundation addresses pressing concerns in basic education through their learning for sustainability programme
- Key tenets in its Learning for Sustainability Framework
- How to engage and educate primary school learners about their environment through situationally relevant lessons

A Snapshot of Education in Indonesia

SCALE
With the fourth largest population in the world, Indonesia’s education system employs 3.3 million teachers, educating 53.1 million children in grades 1 through 12. An additional 231,446 early childhood education providers support 7.4 million children, while 4,670 higher education institutions cater to approximately 8 million students.

SOCIO-ECONOMIC INEQUALITY
Many of those that complete secondary school education do not have the skills needed in the labour market and end up in low-paying work. Low skills reflect poor basic education and poor alignment between education institutions’ curricula and labour market needs.1

Indonesia’s overall learning poverty — the share of children who are either not enrolled in school or not proficient in reading at age 10 — is extremely high, at 35%.2

Poorer students are less likely to move as far through the education system as their more affluent peers; 61% of children from the richest households reach grade 12, while only 23% of the poor do so.3

In this chapter, we learn:
- How the Island Foundation addresses pressing concerns in basic education through their learning for sustainability programme
- Key tenets in its Learning for Sustainability Framework
- How to engage and educate primary school learners about their environment through situationally relevant lessons

2. Ibid.
3. Ibid.
Many children living in remote small island and coastal communities face **systemic barriers** to accessing quality learning, creating an unequal playing field where students must overcome more obstacles for reasons out of their control.⁵

Some of these factors include:
- Economic constraints
- Limited service availability
- Language and cultural exclusion
- Low rates of parents’ engagement in learning
- Inability to attract quality teachers

Given these statistics, the Learning for Sustainability programme developed by the Island Foundation aims to address systemic barriers by providing a holistic after-school curriculum to boost primary school learners’ life skills, and to raise awareness of the environment they live in.

> Children need to learn to collaborate, to have empathy and kindness, to look after each other and the environment, as well as to solve problems and think critically. These skills are important for living fulfilled lives just as much as they are important to contribute to the labour market and society at large.”
> - World Economic Forum, 2023

### The Learning for Sustainability Framework

The Learning for Sustainability Framework is a structured approach to designing, delivering and evaluating extracurricular learning programmes that are specific to the unique challenges and opportunities of small island and coastal communities.

The Framework is structured to provide guidance on the development of learning content for primary school age students who are grouped into lower and upper primary levels, following:

#### LEARNING OUTCOMES
What learners should know, be able to do, and value as a result of their participation in the programme.

#### TEACHING STRATEGIES
The methods, resources and activities that will be used to achieve the learning outcomes.

#### ASSESSMENT & EVALUATION
The methods used to assess and evaluate the effectiveness of the programme.

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Through emphasising the importance of active learning, 21st-century skills development and content-based English language learning, the Learning for Sustainability Framework aims to develop **caring, empowered and reflective** people who share ownership and guardianship of the world we live in.

The framework makes use of knowledge constructed from three core themes that anchor the learning centre programmes:
Understanding man-made disasters and how to prevent them

Primary school students pick up critical literacy and 21st-century skills through the Foundation’s after-school programme in the learning centres. Under the theme “Me and My Earth”, students are taught situationally relevant skills through understanding various man-made and natural disasters.

Subjects covered include:

**SCIENCE**
- Earth and space: geography, tectonic plates, atmosphere, erosion

**SOCIAL STUDIES**
- Humans and the natural environment: interdependence and impact of human activity
- Social organisation, communication and culture

The following unit plan explains how to walk students through the topic of floods caused by trash pollution as an example of using the Learning for Sustainability Framework, to teach primary-level students. The entire unit “Me and My Earth” includes learning about volcanoes, hurricanes, earthquakes and floods, spanning eight sessions.

The main topics covered in this unit are:

**Types of disasters**

- **NATURAL DISASTERS**
  - Earthquakes, volcanoes, hurricanes, floods, fires

- **HUMAN-INDUCED DISASTERS**
  - Floods, pollution, fires, exposure to hazardous materials

**What do we do when disasters strike?**

- **EARTHQUAKES**
  - Practise the tips of “duck, cover and hold”

- **VOLCANIC ERUPTIONS**
  - Hold evacuation drills

- **FLOODS**
  - Protect one’s health during a flood

**How do disasters occur? What causes a disaster?**

**How can we human-induced disasters from occurring and how do we respond to a disaster?**

**Did you know**

Indonesia lies along the Pacific Ring of Fire and has one of the highest rates of natural disasters in the world. It has a 9.7/10 risk index for tsunami occurrences in 2022, with over 164 million people living in earthquake-risk areas. Its risk index for flooding is 8.1/10. It is particularly important for students in small island and coastal communities to understand the world around them, and be taught appropriate skills for protecting themselves in a disaster.

The eruption of Mount Sinabung, North Sumatra, Indonesia in October 2016
SKILLS
By experiencing this unit, students should develop the following skills:

<table>
<thead>
<tr>
<th>Skill</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMMUNICATION SKILLS</td>
<td>Students will be able to express themselves clearly and effectively, both verbally and in writing. This includes skills such as listening, writing, conducting research, and presentation of the project.</td>
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<tr>
<td>CRITICAL THINKING</td>
<td>Students will be able to analyse information, evaluate evidence and make informed decisions on what to do during and after a disaster. They will also understand how to prevent disasters where possible.</td>
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<tr>
<td>COLLABORATION</td>
<td>Students will be able to work effectively with others, both in-person and online. This hones their teamwork, negotiation and conflict resolution skills.</td>
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<tr>
<td>CREATIVITY</td>
<td>Students will be able to develop the ability to think outside the box and come up with new ideas and solutions. They will be encouraged to imagine, be curious and experiment.</td>
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</tbody>
</table>

Desired learning outcomes and unit objectives
As sustainability can be an abstract concept, Ms Sayaka devised ways to connect the discussion to familiar topics.

The first half of the curriculum provided time to input knowledge and concepts, using books and other materials, so that students can broaden their perspectives on a wide range of fields. After that, the curriculum was designed to connect knowledge to society through workshop experiences.

KNOWLEDGE
Under the theme *Me and My Earth*, students will understand the amazing, intricate and interconnected systems of the changing planet we live on. Core knowledge competencies include:

- Understanding the causes and effects of different types of disasters, focusing on human-made disasters.
- Becoming familiar with emergency response procedures and protocols, including evacuation plans and first-aid techniques.
- Knowledge of disaster-preparedness, including how to create emergency supply kits, develop communication plans, and secure property against threats.
- Awareness of the impact of disasters on individuals, communities and the environment, including social and economic consequences.

Throughout the unit, students are guided through each topic using the Learning for Sustainability Framework, moving through the steps of:

- **ENGAGEMENT**
- **EXPLORATION**
- **APPLICATION**
- **REFLECTION**
Through the lesson, students will cultivate the following values:

<table>
<thead>
<tr>
<th>Value</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>CARING</td>
<td>Students understand the importance of empathy and compassion for those affected by disasters, including a commitment to helping others in times of need.</td>
</tr>
<tr>
<td>EMPOWERING</td>
<td>Students build civic responsibility and a sense of duty to contribute to the common good by taking action to prevent or respond to disasters.</td>
</tr>
<tr>
<td>REFLECTIVE</td>
<td>Students gain a sense of environmental responsibility and an awareness of the impact of human activities on the natural world, including how to minimise environmental damage during and after disasters.</td>
</tr>
<tr>
<td></td>
<td>Students build resilience and adaptability in the face of adversity, including the ability to cope with and recover from traumatic events.</td>
</tr>
<tr>
<td></td>
<td>Students gain cultural competence and an understanding of how different cultures and communities may have different needs and responses to disasters.</td>
</tr>
</tbody>
</table>

Carrying out the unit

The unit on disasters is divided up into eight sessions. The whole unit makes use of the key principles:

1. **Hands-on and Inquiry-Based Learning**
   - The lessons should incorporate hands-on activities and inquiry-based learning to encourage students to explore and investigate the topic of disasters, and develop their critical thinking skills.

2. **Assessment for Learning and Reflection**
   - Ongoing assessment should be incorporated into the unit, to inform teaching and learning. Students should have opportunities to reflect on their learning and evaluate their own work, in order to develop metacognitive skills and take ownership of their learning.

**LEARNING ABOUT DISASTERS**

Over the course of the unit, students go through different types of disasters, both natural and human-induced. Main disasters covered in the unit include:

- Earthquakes
- Volcanic eruptions
- Hurricanes
- Tornadoes
- Floods
- Chemical spills and floods from pollution

Students are taught the main triggers for each disaster type, how to prevent them, and the appropriate disaster responses.

Floods, for example, commonly affect most Indonesian communities. Students learn:
- How are floods formed?
- How can we prevent floods from happening?
ENGAGING STUDENTS IN EXPERIENTIAL LEARNING

To let students explore the concepts learnt in the units, the teacher brings students on a disaster awareness walk around the neighbourhood, as well as facilitates a disaster response roleplay.

A disaster awareness walk

Teachers take students on a walk around the school and local community to identify potential hazards, such as unsafe buildings or flood-prone areas. Students are instructed to take photos or make a map of the hazards they find.

Do a disaster role-play

Teachers set up a scenario where students must act out a disaster situation, such as experiencing a flood or hurricane. Roles such as rescuers, victims and emergency responders are assigned to students. This will give students a better understanding of what to do during an emergency situation.

LESSON PLAN

Setting up a disaster walk

Grades: 1-3 (primary)
Subject: Social Studies

Learning objectives

Students will learn about the different types of natural and human-made disasters, understand the importance of preparedness and response to disasters, participate in a disaster walk to identify potential hazards in their community, and develop an appreciation for the importance of protecting themselves and their communities in the event of a disaster.

Materials

- Large, open outdoor space, such as a field or playground
- Printed handouts with safety guidelines

Procedure

Introduction (10 mins)

- Begin by asking students if they know what a disaster is and what types of disasters can occur.
- Use a diagram or model to explain the different types of natural and human-made disasters.

Activity (30 mins)

- Take the students to a large open outdoor space, such as a field or playground.
- Provide the students with printed handouts of safety guidelines, such as staying away from power lines, seeking higher ground in the event of a flood, and following evacuation procedures.
- Instruct students to take a walk around the area to identify potential hazards in their community, such as fallen trees, damaged buildings and blocked roads.
- Encourage students to discuss potential responses to these hazards, such as contacting emergency services or seeking shelter.
- Use the walk to reinforce the importance of preparedness and response to disasters.

Conclusion (10 min)

- Review key points covered in the lesson, such as the different types of natural and human-made disasters, and the importance of preparedness and response.
- Discuss the importance of protecting themselves and their communities in the event of a disaster.

Did you know

One of the common causes of urban floods in Asian cities is the blockage of drainage by improper waste disposal. To prevent this type of flooding, urban infrastructure can be improved; however, changes to human behaviour is also crucial to ensure proper waste management.

SCAN TO READ

more about ongoing studies for flood prevention

SCAN TO READ

more about flooding from improper waste management
After students gain an understanding of common disasters and their causes, the teacher guides them in deepening their understanding of these disasters. The example below shows how the teacher can explore deepening students’ knowledge of human-made floods through an experiment.

**LESSON PLAN**

**Human-Made Floods Experiments**

**Grades:** 1-3 (primary)

**Subject:** Social Science

**Learning objectives**

Students will be introduced to the concept of human-made floods caused by trash accumulation, and will conduct a simple experiment to understand how trash can block drainage systems and lead to flooding.

**Materials**

- Small plastic container
- Dirt
- Water
- Small plastic items such as straws, bottle caps and wrappers
- Small toy cars or other objects to simulate buildings

**Procedure**

**Introduction (10 minutes)**

- Begin by asking the students if they have ever seen or heard about floods in their community.
- Discuss some of the causes of floods, such as heavy rain and overflowing rivers.
- Introduce the idea that human-made floods can be caused by trash that clogs up drainage systems and prevents water from flowing properly.

**Activity (30 minutes)**

- Divide the students into small groups and give each group a small plastic container, dirt, water and a selection of small plastic items.
- Have the students fill the container with dirt, leaving a space at the top for water.
- Ask the students to add some plastic items to the top of the dirt, simulating the way trash can block drainage systems.

**Assessment**

- Observe students’ participation in the disaster walk and their identification of potential hazards.
- Evaluate their understanding of the different types of natural and human-made disasters, and the importance of preparedness and response.
• Have the students pour water into the container, observing how the plastic items prevent the water from flowing through the dirt and causing flooding.
• Encourage the students to experiment with different types and amounts of plastic items to see how they affect the flow of water.
• Place a small toy car or other object in the container to simulate a building and discuss how floods can damage buildings and harm people and animals.

Discussion (20 minutes)
• Lead a class discussion about the results of the experiment.
• Ask the students what they observed and how the plastic items affected the flow of water.
• Discuss the consequences of human-made floods, such as property damage and displacement of people and animals.
• Ask the students what they can do to prevent human-made floods caused by trash, such as properly disposing of trash and participating in community clean-up efforts.

Conclusion (10 minutes)
• Summarise the main learning points of the lesson and review the causes and consequences of human-made floods caused by trash.
• Encourage the students to think about ways they can take action in their own lives to reduce the amount of trash that ends up in drainage systems and prevent human-made floods.

Assessment
Assess the students’ understanding of the lesson through informal observation during the activity and discussion, as well as a brief written or drawn reflection at the end of class. Ask students to draw a picture or write a sentence about what they learned about human-made floods caused by trash and how they can help prevent them.

Students are encouraged to apply what they have learnt, and brainstorm ideas for ways to prevent human-made disasters, focusing on floods. They use their knowledge of the causes of human-made floods, and ways to raise people’s awareness about them.

Students prepare for a poster presentation and practice delivering their presentations.

LESSON PLAN
Taking Action
Grades: 1-3 (primary)
Subject: Social Science

Learning objectives
Students will take action to raise awareness about human-made floods and learn about the importance of community involvement in preventing them.

Materials
• Whiteboard or chart paper
• Markers
• Art supplies (such as construction paper, glue, scissors, etc.)
• Any additional materials for the project as needed (such as flyers, posters, etc.)

Procedure
Introduction (10 minutes)
• Begin by reviewing the causes and consequences of human-made floods caused by trash.
• Explain that the students will be taking action to raise awareness about preventing human-made floods in their communities.
**Activity (30 minutes)**
- Brainstorm with the students ways that they can raise awareness about preventing human-made floods in their communities.
- Write down their ideas on the whiteboard or chart paper.
- Have the students choose one or more ideas to focus on for their project.
- Allow the students to work on their projects individually or in small groups.
- Provide art supplies and any additional materials they may need to create their project.
- Encourage the students to be creative and to include messages about the importance of preventing human-made floods in their projects.

**Discussion (20 minutes)**
- After the students have completed their projects, have them present their projects to the class.
- Encourage the students to discuss their projects and how they hope to raise awareness in their communities.
- Discuss the importance of community involvement in preventing human-made floods caused by trash.

**Conclusion (10 minutes)**
- Summarise the main points of the lesson and review the ways that the students can take action to prevent human-made floods.
- Encourage the students to continue to take action in their own lives and to involve their families and communities in preventing human-made floods caused by trash.

**Assessment**
Assess the students' understanding of the lesson through informal observation during the project and discussion, as well as a brief written or drawn reflection at the end of class. Ask students to draw a picture or write a sentence about one thing they learned from taking action to raise awareness about preventing human-made floods.
3. SKILLED EXPLORER
• Creates a project to raise awareness about human-made floods.
• Project is organised and effectively communicates the importance of preventing human-made floods to the community.
• Demonstrates a basic understanding of the causes and consequences of human-made floods caused by trash.
• Participates in class discussion and offers some constructive feedback to classmates.
• Encourages others to take action to prevent human-made floods.

4. MASTERFUL EXPLORER
• Creates a thoughtful and creative project to raise awareness about human-made floods.
• Project is well-organised and effectively communicates the importance of preventing human-made floods to the community.
• Demonstrates a deep understanding of the causes and consequences of human-made floods caused by trash.
• Actively engages in class discussion and offers constructive feedback to classmates.
• Encourages others to take action to prevent human-made floods.

After preparing their projects and presenting them to the class and the teacher, students are led through a short activity to help them synthesise what they have learnt about flooding caused by trash accumulation. This activity helps students recall key information about human-induced floods, and reinforces the ways they can take action to prevent this type of flooding.

LESSON PLAN

Reflection
Grades: 1-3 (primary)
Subject: Social Science

Learning objectives
Students will reflect on the concept of human-made floods and how they can help prevent them.

Materials
• Paper
• Crayons or markers
• Chart paper or whiteboard
• Pictures or videos of floods caused by trash (optional)

Procedure
Introduction (10 minutes)
• Begin by reviewing the concept of human-made floods caused by trash from the previous lesson.
• Discuss with the students what they learned and ask them to share any questions they still have about the topic.
Challenges and solutions in lesson implementation

**Activity (30 minutes)**
- Divide the students into small groups or pairs and give each group a piece of paper and crayons or markers.
- Ask the students to draw a picture of a neighbourhood or community that is affected by flooding caused by trash. Encourage them to be creative and include details such as trash in the streets, water overflowing, and people and animals in need of help.
- After the students complete their drawings, have each group share their picture with the class and explain what they drew and why.
- As a class, create a chart or list of ways to prevent human-made floods caused by trash. Examples could include picking up trash, recycling and properly disposing of waste.

**Discussion (20 minutes)**
- Lead a class discussion about the pictures and ways to prevent human-made floods caused by trash.
- Ask the students how they can take action in their own lives to help prevent human-made floods.
- If available, show pictures or videos of floods caused by trash to help the students understand the real-world impact of the problem.

**Conclusion (10 minutes)**
- Summarise the main points of the lesson and review the ways to prevent human-made floods caused by trash.
- Encourage the students to think about ways they can help prevent human-made floods in their own lives and communities.

**Challenge**

<table>
<thead>
<tr>
<th>Potential solution</th>
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<tbody>
<tr>
<td><strong>EMOTIONAL RESPONSES OF STUDENTS</strong></td>
</tr>
<tr>
<td>Students may become overwhelmed or upset by the topic of disasters, which can lead to emotional responses such as crying, anxiety or fear.</td>
</tr>
<tr>
<td>Teachers can provide a safe and supportive learning environment where students feel comfortable expressing their emotions. Teachers can also provide students with coping strategies and resources, such as breathing exercises or a quiet space to take a break if needed.</td>
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</tbody>
</table>

| **SHORT ATTENTION SPAN** |
| Lower or even upper primary students may have a limited attention span and may become distracted or restless during lessons. |
| Teachers can break up lessons into smaller, more manageable chunks, and incorporate movement breaks or transitions to keep students engaged. Teachers can also use a variety of teaching strategies, such as visual aids or hands-on activities, to keep students interested and focused. |

| **DIFFERENT LEARNING STYLES** |
| Lower and upper primary students may have different learning styles, with some students preferring visual aids and others preferring hands-on activities or auditory learning. |
| Teachers can incorporate a variety of teaching strategies and resources to accommodate different learning styles, such as visual aids, manipulatives or songs and chants. Teachers can also allow students to choose how they want to demonstrate their learning, such as through drawing or writing. |
**STUDENT ENGAGEMENT**

The students were actively participating in class, and some were even directly involved by commenting on disasters that had occurred in Indonesia. They also asked critical questions about disasters and what can be done to prevent them.

**Reflective questions:**
- Were your students participating actively in lessons?
- Did they seem interested in the topic of disasters?
- Were they engaged in the hands-on activities?
- Did they ask questions and contribute to discussions?

**CLASSROOM MANAGEMENT**

The class was calm when learning about topics like earthquakes. During a volcano experiment, things got a bit messy, but the students worked together to clean up the vinegar and baking soda mixture. Messy learning activities like this can be fun and engaging for students and can also encourage teamwork.

**Reflective questions:**
- Were there any disruptions or behaviour issues that you could have addressed better?
- Did you establish clear expectations and rules for behaviour?
- Did you provide positive reinforcement for good behaviour?

**ASSESSMENT AND FEEDBACK**

We provided formative assessment and reflection activities at the end of each learning session. Students were also given space to share feedback with each other.

**Reflective questions:**
- Did you provide ongoing formative assessment to monitor student progress?
- Did you provide opportunities for students to reflect on their learning and evaluate their work?
- Did you provide timely and specific feedback to help students improve?

**OVERALL REFLECTIONS FROM THE MODULE**

We could use learning stations and choice boards to engage students at different levels and cater to different learning styles. For instance, we could use a choice board that allows students to select a task based on their interests, such as researching a specific type of disaster or creating a presentation on the impact of disasters on communities. Alternatively, we could use collaborative learning, where students work in small groups to research and present on different aspects of a disaster — such as its causes, impacts and prevention strategies. By using differentiated activities, we can ensure that all students are challenged and engaged in their learning.

**Reflective questions:**
- Did I achieve the intended learning outcomes?
- Did students demonstrate an understanding of the content?
- What worked well and what can be improved?
- What changes would I make for future lessons?
1.2

*Our Sustainability: Creating a student-centric sustainability education curriculum*

Ms Sayaka Matsukura

Integrated Studies is a unique subject in the Japanese curriculum, being the only subject that is non-examinable. Teachers are given much freedom in designing the curriculum, with the intention to broaden students' knowledge through cross-disciplinary learning, and hone critical thinking and problem-solving skills. Ms Sayaka Matsukura of Inagakuen Junior High School crafted a unique curriculum for her students to dive deep into the history and social implications of sustainability issues, and to explore the necessary actions for a more sustainable society, by centring the curriculum around the book, *Our Sustainability.*

**In this chapter, we learn:**

- How to develop a sustainability education curriculum around specific educational resources
- How to guide students through a self-driven and project-based sustainability education curriculum
- How to make use of “systems thinking” to guide and craft research topics

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**Life lessons in Integrated Studies**

Integrated Studies is a cross-curriculum subject implemented in elementary and junior high schools in Japan. The main goals of the subject are to develop students’ aptitude for problem-solving, and to let them critically and creatively reflect upon their own lives through the inquiry-based curriculum. For this unique subject, teachers are free to set the topic for the term, and it is the only subject in the school curriculum that does not have exams.

As such, it is important to establish the main theme of inquiry for each school and grade level, and to plan the unit structure together with teachers and students so that the latter can develop interest in and benefit from the lessons. In Ms Sayaka's class, she sets the topic based on students’ overall interests, and classes are designed to allow students to make their own decisions.

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**What does Integrated Studies time mean to you?**

"Time to think about questions without answers.
Time to constantly question.
Time to consider things from diverse perspectives.
Time to notice connections.
Time to rethink and revaluate one's own ideas.
Time to think about the background of what is happening in society.
Time to reflect on one's own life and lifestyle.
Time to think critically.
Time to get in touch with the fundamentals of the world."
In 2022, Inagakuen Junior High held workshop-style classes for Integrated Studies focusing on inequality, climate change and gender issues to allow students to gain awareness on these pressing global issues. While many students were introduced to the topic of the Sustainable Development Goals (SDGs) and how companies and international organisations dealt with them, there remained a shallow understanding of sustainability and sustainable development. As such, in 2023, Ms Sayaka and her class decided to dive deeper into the topics of what sustainability and sustainable development mean — to societies and to the students themselves.

Our Sustainability

For her Integrated Studies classes during the term, Ms Sayaka chose to focus her lessons around the book titled Our Sustainability by Dr Shogo Kudo — a book specially written for junior high and high school students who are learning about sustainability for the first time, and want to know the basis for the SDGs.

It is common for many students to only know about the SDGs through their icons and media reports, and not the concepts behind them. Thus, the book is designed to facilitate a class, focusing on the main question:

What is the concept of sustainability in the first place, and how do we need to change in order to realise a sustainable society?

By anchoring her class on this big question, Ms Sayaka introduced her students to diverse values, and helped them look critically at issues to consider what is required for social transformation to create the sustainable society Dr Kudo speaks of.

Creating the Integrated Studies curriculum

In developing the curriculum, Ms Sayaka and her colleagues referred to the spiral-based learning framework shown on the right side of the figure below. This curriculum is imagined as a one that is developed together by the students and the teachers, where they depend on one another to complete the curriculum.
Teaching Our Sustainability in Integrated Studies

There is a diversity of lessons that deals with issues such as climate change and food loss. However, many of them do not sufficiently address the contributing factors and background of the problems, such as explaining to students how these problems exist and are perpetuated. In addition, when such issues are addressed in the classroom, students are often passive as they work through the learning plan prepared by the teacher.

In this programme, Ms Sayaka focused on the circumstances behind the problems, with the aim to transform social structures. At the same time, the curriculum is organised according to the students’ questions, so the class evolves based on their own decisions.

Desired learning outcomes and curriculum objectives

As sustainability can be an abstract concept, Ms Sayaka devised ways to connect the discussion to familiar topics.

The first half of the curriculum provided time to input knowledge and concepts, using books and other materials, so that students can broaden their perspectives on a wide range of fields. After that, the curriculum was designed to connect knowledge to society through workshop experiences.
The main topics covered in this lesson are:
- Environmental, social and economic issues as related to the SDGs
- Systems thinking

**KNOWLEDGE AND SKILLS**
By moving through lessons and asking their own questions, students are expected to:

- Understand the issues surrounding sustainability and analyse the background and stakeholders of these issues.
- Express what a sustainable society can look like, and how they can contribute to such a society through working with various stakeholders.
- Set their own goals for sustainable living, and identify which social structures need to be transformed and how.

**VALUES**
By the end of the term, students cultivate the values of:

**Responsibility and ownership**
Students will find connections between their daily lives and social issues and understand that they are responsible for their own actions. Students will become aware of their own participation to create a sustainable society.

**Care and collaboration**
Students develop compassion for the community, and connect what they have learnt to how it can change and impact society. They learn the importance of working with different people to achieve the goal of a sustainable society as a collective.

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**Carrying out the Integrated Studies term**
Through using the spiral curriculum method and IBL, Ms Sayaka’s Integrated Studies curriculum went through two large cycles of inquiry.

**READING AND ASKING QUESTIONS**
Students read the book *Our Sustainability* By Dr Kudo to have a deeper understanding of the core terms, history and concepts. While reading, they were asked to write down their own questions about the topic.

Some questions the students came up with were:
- What is the origin of the word “sustainability”?
- What is the difference between equality and equity?

Achieving a sustainable society requires social transformation. Simply learning about the SDGs and dealing only with visible social issues such as climate change and food loss is not enough to transform society. Therefore, Ms Sayaka chose to introduce the broad theme of sustainability to her students through a book, encouraging reflection and deep thought.

**LECTURES FROM SPECIALISTS**
To deepen the conversation, Ms Sayaka invited Dr Kudo to host a talk with her students. He questioned students on their impressions of sustainability after having read the book, and delivered a lecture on systems thinking.

Another lecturer, Ms Eri Yamazaki of Sophia University in Japan, was invited to share her research on how a community in Kenya faced disruption from dam construction.
Ms Sayaka’s students participating in group discussion and reflections

Ms Sayaka’s students participating in group discussion and reflections

Dr Kudo delivering his online lecture to Ms Sayaka’s class during the pandemic

I learned new ways of perceiving and researching things from Dr Kudo’s talk, and I learned how to look at things from many different perspectives.”

FACILITATING DISCUSSIONS

After reading the book and having a better understanding of the history and development of sustainability concepts, Ms Sayaka facilitated a discussion with her students. Some of the questions asked were:

• What is a sustainable society, and what is an unsustainable society?
• When is there an imbalance between human activity and the natural environment?
• What is the meaning of “development”?  
• The book assigned is titled Our Sustainability. Who does “our” include, or not include?

PARAPHRASING “SUSTAINABILITY”

To deepen students’ understanding of what they have learnt about sustainability, Ms Sayaka encouraged them to explain what sustainability meant without using the word.

Tip

Teachers should act as facilitators and ask students probing questions (e.g., “for example?” “what do you mean by that?”) to encourage students to support their perspectives with real-world references and personal experiences. The teacher should spend most of the time listening to students’ responses, rather than guiding them to a “correct” answer.
2. Consider how they paraphrased the word “sustainability” in a previous assignment

These connections help students to expand their idea of what sustainable actions can include, and find instances of that in their community.

At the start of the second semester, students presented their findings and shared ideas and instances they found inspiring.

A student wrote about her homemade curry and rice as an example of sustainable behaviour. When she cooked the meal, she did not peel the skins of the vegetables. She realised the taste was equally good, and the meal felt rich in nutrition.

If more people left the skins on when cooking vegetables, we could prevent much food waste.

Another student took a photo of a board showing “sign language”. She found this board in the park near her house.

She thought if more people learnt sign language, we would be able to better communicate with deaf people.

I have paraphrased sustainability as ‘thinking and acting’. What do we want to make sustainable? I thought about what we can do and how we can apply it to our daily lives. Simply thinking about it will not improve the global environment. It is important to apply what we think about in class and in discussion to our daily lives and to take action (i.e., make choices and decisions) to improve the global environment.”

MAKING A PHOTO REPORT

During summer vacation, the students prepared a photo report assignment. They were to take pictures of scenes, landscapes and occasions that they thought were sustainable and record them down. This is part of encouraging students to think about what is “my sustainability”.

To prepare students for the assignment, Ms Sayaka asked students to consider two tasks:

1. Try to have an image of what sustainability meant to them

   Students wrote down related words and synonyms with respect to sustainability, such as “green nature”, and “finding connections among people”.

2. Consider how they paraphrased the word “sustainability” in a previous assignment

   These connections help students to expand their idea of what sustainable actions can include, and find instances of that in their community.

   At the start of the second semester, students presented their findings and shared ideas and instances they found inspiring.

   A student wrote about her homemade curry and rice as an example of sustainable behaviour. When she cooked the meal, she did not peel the skins of the vegetables. She realised the taste was equally good, and the meal felt rich in nutrition.

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   Another student took a photo of a board showing “sign language”. She found this board in the park near her house.

   She thought if more people learnt sign language, we would be able to better communicate with deaf people.
Using their photo reports as a starting point, Ms Sayaka's students brainstormed on topics of interest to focus on during the semester, with the prompt: “What do you want to make sustainable?”

Students then formed groups with peers who had similar topics of interest, and began researching for their inquiry.

Topics from students include:

- Food loss and shortage
- What is a sustainable town?
- Ethical fashion
- Protecting the ecosystem
- What is a green economy?

After students were grouped together, each group discussed and decided on a specific research topic and came up with a research plan. To inform themselves on their area of interest, students read books and other materials, keeping in mind these three leading questions:

1. What is the problem you are targeting?
2. What is the background and history of the problem, and how does its history relate to what is happening now?
3. Who are the people and organisations involved in this issue?

**Tip**

When deciding on a theme, it is important to respect the students' decision and leave it to them. By basing their learning on their own decisions, rather than on the teacher's instructions, students feel motivated and responsible for their own learning.

Using systems thinking, Ms Sayaka emphasised the importance of not just looking at the surface of things, but what lies behind them — thus getting students to focus on societal structures and how to change them. She consulted the book *Systems Thinking for Social Change* by David Peter Stroh to inform her lesson.

An example of one group's research area on ethical fashion:

**TOPIC**: What is the problem between the environmental issues and fashion industry and how we make them better to ethical ways?

**AIMS OF STUDY**: Find and implement what is required of the world in the future (governments, companies, and all private sectors) and what we can do to eliminate the negative effects of fast fashion, such as unfair labor, human rights violations, and CO2 emissions due to mass incineration.

**Research Questions**
1. To find out what kind of attitudes we, living in developed countries, have towards clothing
2. What is the reality of slow fashion?
3. What is the sustainability of fashion?
   - (Check online shops. Visit the fair trade shops in Tokyo and get interviews)

**Members**

A group of students conducting their research
CONDUCTING RESEARCH AND ANALYSIS

Based on each group’s research plan, the students conducted exploratory studies through:

1. **Reading resources like books and newspapers**
   This is a good opportunity to encourage the use of library resources. Students not only rely on the internet, but also enlist the help of the school librarian.

2. **Group discussions with team members and guest speakers**
   Dr Kudo and Ms Yamazaki were both invited to Inagakuen Junior High to share their research experiences and answer the students’ questions.

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**Student voice**

“I was impressed by the beautifully patterned cloth in front of me [shown in Ms Yamazaki’s lecture]. I wanted to buy one too. I also feel that it was an important opportunity for us to think about environmental issues and labour environment issues in connection with clothing.”

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3. **Conducting field work**

Students conducted field work as part of their inquiry study. Each group decided on where they would visit based on their topic of choice, with students visiting different companies, non-profit organisations, universities, and other specialists to conduct interviews with them and collect research materials.
Challenges and solutions in lesson implementation

**Challenge**

**CURRICULUM DEVELOPMENT**
Sustainability is a very broad concept, and it can be overwhelming to know where to start or how to create a meaningful and holistic curriculum for students.

**Potential solution**
Ms Sayaka’s Integrated Studies curriculum was developed with the aid of sustainability researchers, who gave pointers for promoting a broader yet deeper study into the topic.

**SETTING TOPICS**
If the research topics students set are not clear, it will be difficult for students to carry out the tasks.

**FIELDWORK**
It may take lots of time and logistical coordination to arrange for site visitations and speakers.

**Potential solution**
Provide adequate time for refining research topics, and for conducting the necessary research. Ms Sayaka used workshop experiences and her students’ photo report task to help students refine their topics for research. The topics were concrete and complete with leading questions.

**MAKING A GROUP REPORT**
At this last stage, students were tasked to prepare a group report summarising what they had learnt through research, analysis, and fieldwork. Their poster presentations covered the following:
- Research topic
- Research objectives
- Response to research question
- What will be changed in individual behaviour/society to achieve sustainability, and how?

**Tip**
The report should not only reflect on the fieldwork, but also focus on what was achieved or not achieved throughout the entire study. Encourage students to send the completed report to the people and organisations involved in the study to get their feedback.

**CONSOLIDATING LEARNING AND REFLECTION**
Although this was the first time we created a curriculum anchored around a single book, having just one book in common allowed us to share our knowledge of sustainability in great depth.

It took time to think about the big question: *What is the concept of sustainability in the first place, and how do we need to change in order to realise a sustainable society?*

Therefore, we started out by asking “what does the word mean?” After the class, many students kind of became obsessed with words and their meaning!

Throughout the entire curriculum, we were aware that this was a class where students create their own curriculum. The general flow of the curriculum was presented by the teacher, but students were encouraged to think about and decide on specific topics and questions. In reflection, however, there may have been times when we still could have left more of the learning to the students.

- Ms Sayaka Matsukura

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**Teacher’s reflections on the lesson**

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**Seeds to table: A holistic nutrition curriculum in Green Studies**

Ms Ida Rahayu

Have you ever considered where your food comes from? Modern-day lifestyles mean we have busy schedules that leave us reliant on supermarket produce and fast food chains, rarely thinking about what goes into growing the food we eat. Ms Ida walks us through her three-year Green Studies curriculum at Green School Bali, where she teaches students about the importance of nutrition, and highlights pertinent problems in the contemporary global food system that causes people to develop health problems when they do not consume healthy food. She wraps up the three-year curriculum with a final application project, where students apply what they have learnt about permaculture and nutrition to create and sell their own healthy meals at The Green Warung: a student-run eco-food business.

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**In this chapter, we learn:**

- What permaculture is and what is required to grow organic, self-sustaining and healthy edible gardens
- What nutrition and nutrients are, and what is required for a healthy human diet
- How to apply knowledge in food and nutrition to run a successful student-operated café selling healthy, organic, home-made meals at The Green Warung
Seeds to Table: Permaculture in nutrition education

When Ms Ida started teaching food education in Green School, Bali, she started with a cooking class as an elective experiential programme. After being introduced to permaculture and its philosophies in 2016, she began to integrate permaculture concepts into her food education classes. It was important for students to understand where their food comes from, as well as how to grow their own food, to have a holistic nutrition education. It was then she founded the Seeds to Table programme, a term-long experiential programme for middle school students to get into the knowledge and complexities of agriculture and nutrition. The programme then covered topics of:

- Growing edible gardens
- Making compost
- Cooking
- Waste management

Permaculture was originally defined as “Permanent Agriculture”. It is an integrated, evolving system of perennials or self-perpetuating plants and animals useful to humans. Permaculture is the conscious design and maintenance of agriculturally productive ecosystems that have the diversity, stability and resilience of natural ecosystems. It is the harmonious integration of landscape and people — providing their food, energy, shelter and other material and non-material needs in a sustainable way. Permaculture imitates the no-waste, closed-loop systems seen in diverse natural systems, while tapping on a multidisciplinary knowledge base of agriculture, hydrology, energy, forestry, animal systems, and many other processes involved in growing food.

Learning about permaculture changed the way I think about our connection with nature, and made me understand how we need to be in harmony with natural cycles to survive. Growing food is essential for human survival, yet agriculture’s negative impacts on the planet are massive. This is why I am passionate about permaculture education as a way to encourage awareness of clean and healthy eating, and as a form of sustainable agriculture.”

- Ms Ida Rahayu, Green School educator and founder of the Seeds to Table Programme

“We are what we repeatedly do. Excellence, then, is not an act, but a habit.”

- Aristotle
Did you know

Green School Bali is renowned for their eco-architecture and “living” curriculum that educates for sustainability through community-integrated, entrepreneurial learning, in a wall-less and nature-immersed environment. Since the opening of its first campus in Bali in 2008, the global Green School movement now has campuses in New Zealand, South Africa, and soon, Tulum in Mexico.

An overview of the Green Studies curriculum at Green School Bali

**GRADE 6**

At this level students start with learning about **permaculture ethics: earth care, people care, and fair share**. One way to apply these ethics is by growing their own food and medicine in a regenerative way to promote a healthy life and planet.

Topics covered in Grade 6 are:

- **Terms 1 & 2:** Permaculture Guild principles
  - Students grow an edible garden from seeds using Permaculture Guild principles. This topic covers what healthy soil is and its importance to our health and also the health of the planet, how to keep soil healthy by planting biodiversity and using a biological pest control system.

- **Term 3:** Medicinal plants
  - Students get to know medicinal plants, how to grow them, and how to include them in our daily life consumption.

- **Term 4:** Sprouts and microgreens
  - Students learn about sprouts and microgreens, their health benefits, and how to grow them.
GRADE 8

Grade 8 focuses on food production and enterprise. After going through two years of the Green Studies curriculum and understanding permaculture principles and healthy eating, students are led to put this knowledge into practice. They reflect on existing food systems and how they can incorporate sustainable eating this into their own lives, while finding opportunities to create sustainable healthy food businesses and exercise entrepreneurship skills.

Topics covered in Grade 8 are:

**Term 1:**
**Food Philosophy**
Students understand the definition of food, what the current global food system is like, and the impact of food systems on our health and environment.

**Term 2:**
**Food Enterprise (creating individual products)**
Using their knowledge of food philosophy, students work on creating a food product that is healthy and sustainable. They work on designing meal menus, sourcing local and organic ingredients, food packaging and marketing.

**Term 3 & 4:**
**The Green Warung Project**
Over two terms, students manage their own food-based business as a food vendor, where they can experience having a real job within the food industry. They apply for a job at The Green Warung, work and get paid based on their profit. Each student has a role to get the business going. They create their own menu that is aligned with Green School’s food & beverage policy and healthy food philosophy that they learned in Term 1.

With this curriculum design, students not only learn about sustainability, but also experience and learn life skills to enact sustainable living practices. Through creating their own healthy food products using sustainable food philosophy, and understanding how to grow their own permaculture garden, students integrate knowledge on how to maintain their own health and well-being and create a positive impact on the planet.

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GRADE 7

In Grade 7 students explore the roles of animals and microorganisms in the ecosystem and how they are beneficial to our food system.

Topics covered in Grade 7 are:

**Term 1:**
**Living with bees**
Students explore facts about bees and the role of bees in our ecosystem as well as their health benefits to the human and non-human community.

**Term 2:**
**Chickens & Deep Litter Composting System**
Students learn all about raising chickens, including understanding the food they need, their habitat, anatomy and how to maintain a chicken farm to incorporate it in their food system.

**Term 3:**
**Detritivores**
Students understand the role of microbes, insects and other animals in helping them manage organic waste through composting.

**Term 4:**
**Fermentation**
Students learn the roles of microorganisms in and on our body and how fermentation is a way to improve our gut health. They learn different types of fermentation and experiment in making their own fermented products, such as kombucha and tempeh.
Students will be able to think critically to express or share opinion around our food system challenges and what the solutions could be.

Critical thinking skills will allow students to dig deeper into a situation/event with logic and creativity by asking questions, analysing and drawing conclusions to form an opinion or solution.

Knowledge and Skills
From this project, students will be able to gain the following knowledge and skills:

From Term 1, Lesson 1
UNDERSTANDING FOOD SYSTEMS

Knowledge and Skills

- Students will be able to have an awareness of what our current food system is like and the impact of it to our health and environment.

Reasons

A lot of us are really disconnected with what we eat, and our food system is one of the reasons why. A lot of convenient, highly-processed food is available on the market which impacts our health and environment when consumed frequently. It is important to have our students gain awareness of what they put into their body and the impact of food and nutrition on their health.
VALUES
By the end of the term, students cultivate the values of:

<table>
<thead>
<tr>
<th>Value</th>
<th>Reason</th>
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</thead>
<tbody>
<tr>
<td>CARE FOR SELF AND THE PLANET</td>
<td>Values are not something that we could teach in class. Character is built over time. It is important to give students tasks for them to work on and build values in the most natural way, through experiences.</td>
</tr>
<tr>
<td>RESPONSIBILITY</td>
<td>Students feel responsible in their individual roles, understanding their own importance in making the business function smoothly.</td>
</tr>
<tr>
<td>EMPATHY AND COMMUNITY</td>
<td>As their jobs require teamwork, students learn to empathise with one another while working together to solve larger problems in the community. Sometimes this means dealing with peers, teachers, staff and even parents who frequent The Green Warung.</td>
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Knowledge and Skills

- **Active listening** is an important skill to have. Often in daily conversation or in the classroom, the urge for students to speak at any time is common. This will not work in professional meetings with set agendas. By emphasising that in a business, time is money, they learn how to maximise meeting times, maintaining discipline while getting the job done.
- **Leadership skills** help students build confidence and teach them a sense of responsibility. These are important qualities to develop at a young age.
- **In real life, challenges happen at any time. Students should be taught to remain flexible and resilient in the face of challenges, and learn how to respond to them as they move through the day.**

Reasons

- Students can develop leadership skills and take initiative fulfilling their different roles and responsibilities.
- Students can develop problem-solving skills through encountering challenges on the job, which require them to work with their team to solve.
- Students can express ideas and opinions while practising active listening during group meetings with peers.
Carrying out the lessons

**DEFINING “FOOD”**

Students work individually to reflect on what food is to them. They are then asked to find common definitions of food from dictionaries and websites.

Getting students to ask themselves the simple question of: “What is food?” and sourcing dictionary definition helps students dig deeper into what they consume daily and what goes into their bodies.

For example, a simple online dictionary search brings up the *Oxford Languages* definition of food:

“Any **nutritious** substance that people or animals eat or drink or that plants absorb in order to maintain life and growth.”

Recurrent language definitions of food, and student self-reflections on defining food, all lead to the emphasis of food being a **source of nutrients** for the body to produce energy and sustain growth.

**WHAT ARE NUTRIENTS?**

After students connect their understanding of food to common definitions of the term, the teacher leads students in a discussion about **nutrients** and **phytonutrients**. The class work through the following resources together:

- **What is nutrition?**
- **Phytonutrients:** Paint your plate with the colours of the rainbow

Moving through the resources, the teacher emphasises the different types of nutrients a healthy human body needs, food types and portions that can lead to a balanced diet, and how to choose the right foods that give us the right amount of nutrients per meal.

In this exercise, the teacher displays an array of packaged food on the table (the ones students most likely love to eat!) such as instant noodles, canned meat and sweets. Students will be handed a package of food, and asked to identify:

- The ingredients listed on the packet
- Where the food item was produced (country of origin)

This is a good exercise to build awareness as students often check the packaging for nutrition or calorie count, but do not check the ingredients.
From this, students are then asked whether they can recognise all the ingredients in the list, and what could be the health impact of consuming all the ingredients listed.

If the packaged item was produced abroad, the teacher then asks students to think of the environmental impact of importing products and plastic packaging, and when these become waste.

This exercise helps students understand what they are ingesting when they consume their favourite packaged food, and bring awareness about how over-consumption of convenient, mass-produced packaged food and drink can damage their health and the environment.

After the food packaging exercise, Ms Ida walks students through a brief evolution of food through human history, and how we end up with the food we eat today. The milestones covered are:

1. Food during the primitive hunter-gatherer period (1–3 million years ago)
   - Transition from eating raw fruits, nuts and leaves to eating meat, and the change in human biology because of the change in diet.
   - Discovery of fire that led to cooking food.

2. The Homo sapiens species and agriculture (200,000 years ago)
   - Start of the agriculture era where humans grew crops and domesticated animals.
   - The first domesticated plant and animal were wheat and sheep.

3. Food preservation part 1
   - Food preservation techniques were often discovered by chance.
   - Examples are drying, fermentation and smoking.

4. Food preservation part 2
   - Food preservation through salting and brining was discovered 6,000 and 2,000 years ago, respectively.
   - Canned food was invented in 1700, but needed refinement to avoid food poisoning.
   - Chemical food preservation began in 1900.
5. Modern eateries
   a. The first restaurant started in Paris in 1765 served soup; back then, going to the restaurant was a recreational activity to relax. The word “restaurant” originally came from the Latin word *restaurare*, which means “to renew”.
   b. Today, people go to restaurants to eat. Urban lifestyles mean people who work may not have time to cook, and the demand for restaurants grew.
   c. Fast food is also on the rise due to people’s increasingly demanding schedules. Not only do people not have time to cook, they do not have time to eat. The rise of joints like McDonalds and Wendy’s correlates with the sharp increase in obesity and other cardiovascular diseases.

6. Supermarkets
   a. Canned food was invented in the late 1700s, and plastic food packaging in the 1800s.
   b. Before World War II, people used to grow most of their own food in backyards or farms; now most rely on supermarkets to buy groceries.
   c. It is now near impossible to avoid consuming food without unwrapping food packaging and contributing to plastic waste.

7. The Green Revolution
   a. Human populations kept rising in the 1940s, until there was a food shortage. The Green Revolution was a response to feed a growing human population.
   b. The Green Revolution perpetuated a type of agriculture heavily reliant on chemical fertilisers and lots of water, and does not work in countries with minimal water supply.

8. Genetically Modified Food
   a. The Monsanto Company started as a chemical company in 1901, producing food additives like saccharin, vanillin and caffeine.
   b. In 1980 Monsanto invented genetically modified crops and patented the seeds. Many of these seeds, once harvested, are unable to reproduce to sow a next generation of crop.
   c. Monsanto is famous for using the glyphosate-based herbicide called Round-Up, a toxic agent causing cancer and birth defects.
   d. Examples of genetically modified crops are soy, corn, canola and tomatoes; the first animal to be genetically modified was salmon.

By getting students to understand the history of food, students can understand how modern food systems come to be, and the healthy choices they are able to make for themselves and the planet.

At the end of the lesson, students are asked to write a reflection on what they understand about healthy food, and reflect on their own eating habits.
ASSIGNING ROLES AND RESPONSIBILITIES

Students have been assigned their roles and responsibilities in previous classes. These are:

- General Manager
- Marketing Manager
- Finance Manager
- Cashier
- Head Chef
- Chefs
- Purchasing Manager
- Waiter

The teacher acts as the supervisor, and steps in to assist if needed. Green Studies classes are two hours long, and held weekly. For this project, students can collectively decide how many days The Green Warung is open. Students set up and manage this green food business and sell their food to the school community during snack break and lunch break. They are paid for their time through the profits generated.

MORNING BRIEFING

The morning briefing is led by the General Manager. The General Manager would have prepared a slideshow of what went well in the last week of sales, what challenges they have faced, and what are the potential solutions. The briefing also covers reports from each department (marketing, kitchen, finance and housekeeping) and new ideas the team may have.

PLANNING AND PREPARING

Students are introduced the Green School’s food & beverage policy, with guidelines that the food at school should be fresh, minimally processed, nutritious, locally sourced, and organic. The menus created by students each week need to meet these criteria.

Students also tap on their prior knowledge of nutrition and growing permaculture to choose healthy ingredients and the right balance of nutrients to create the menu. Where possible, the students harvest and use ingredients grown directly on school grounds from their permaculture gardens.

In this lesson plan, Ms Ida takes us through the fifth class of the term, after students have already been introduced to their roles in The Green Warung. Students are employed and paid by the school, simulating that they are real employees working a business. They are also allowed to quit the job at any time if they wish.

The objective of The Green Warung is to get students to implement what they have learnt about food and nutrition through the whole Green Studies curriculum, by creating clean and healthy food products that both benefit the community and reduce harmful impact on the planet. Through this project, students also pick up apply entrepreneurial skills in order to make their Green Warung food business a success.
Examples of menu item descriptions on The Green Warung pre-order form

Rainbow Salad (40k) (V/Vg) — Colorful variety of mostly organic vegetable: lettuce, blanched broccoli, red cabbage, carrot, cucumber, corn, ponelo, red paprika microgreens, pumpkin seeds and sunflower seeds with option of Garlic Tahini or Miso Ginger dressing (Hard boiled egg available for 5k extra per egg) — available only at lunch

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<tr>
<td>Salad</td>
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Garlic Tahini dressing

Rainbow salad with Miso Ginger dressing

Tomato Pasta

Peanut Butter and Jam Sandwich (28k) (V) — Sandwich with homemade peanut butter and rosella jam (rosella harvested from our garden) — available at snack and lunch break

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<tbody>
<tr>
<td>Peanut</td>
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The menus created by The Green Warung employees include the name of the dish, the estimated calorie intake for the meal, dietary specifications (such as vegetarian or gluten-free), and a description of the ingredients that make up the dish.

Students then carry out their jobs to create and sell healthy meals:

**MANAGER**
Supervise the group and take notes on individual performance. This performance appraisal informs the percentage of profits they earn as wages.

**PURCHASING MANAGER**
Check for menu updates and work with the Head Chef to create shopping lists. They can search for sustainable suppliers and support local farmers.

**HEAD CHEF**
Manage the kitchen team and prepare food and beverages. Meet with the Purchasing Manager to make shopping lists.

**CHEFS**
Work with the head chef to prepare the food and beverages for sale.

**CASHIERS**
Prepare the laptop for recording sales, update the menu list and food prices, create and manage the pre-order list and assist the Finance Manager.

**MARKETING**
Update sales flyers and menus as needed, manage the pre-order form. Create a website, take photos of products, and create emails to the community on business updates.

**WAITERS**
Prepare the dining space and assist the kitchen in food preparation to be ready for service.
The Green Warung is open and students sell their meals to the school community. Food ordered through the pre-order form is made and customers either collect it at The Green Warung or have it delivered to them at an additional fee.

At the end of the day, the Cashier and Finance Manager count the profits and record the sales made for their healthy meals.

This activity allows students to gain real-world experience through selling their meals to a community beyond just their team or class. They encounter many types of customer profiles, and this allows them to hone their social and communication skills.

### Challenges and solutions in lesson implementation

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<tr>
<th>Challenge</th>
<th>Potential solution</th>
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<tr>
<td><strong>TEAMWORK AND DYNAMICS</strong></td>
<td>Emphasise at the beginning of class that they are learning to be professionals during this activity, and that they should manage interpersonal relations to not let them affect their work. During serious conflicts, involve a school counsellor.</td>
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<tr>
<td><strong>USING ONLY LOCALLY-PRODUCED INGREDIENTS</strong></td>
<td>The teacher can couch using only local ingredients to produce a meal as a challenge to students, and find creative ways to replicate a similar flavour, but with a local Balinese twist. Sometimes the adapted recipe is more interesting and tastier than the original!</td>
</tr>
</tbody>
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### A change in behaviour

After her child went through the Green Studies term, a parent mentioned how the student reminded her to check ingredients listed on food packaging to ensure they were healthy. Another parent shared how after the term, his child cooked more of his meals instead of buying fast food or eating out so often.
The Bhutan Baccalaureate is a new programme and qualification that aims to provide high-quality, holistic education through secondary schooling, which is currently being trialled at two schools in Bhutan and India. It aspires to help learners actualise their inner potential as constructive, contributing citizens of communities through continuous, self-drive growth in five areas of development (social, emotional, spiritual, physical and cerebral) and thereby foster the evolution of a just and harmonious society. Through adopting the core principles of the Bhutan Baccalaureate, Mr Thinley Wangchuk shares about conducting a gallery walk as an activity for pre-service teachers to build critical thought around sustainability and develop personal responsibility to the environment and community.

The Bhutan Baccalaureate: Holistic education for sustainability

Motivated by a need to cultivate future leaders who can face the multifaceted opportunities and challenges of this era, His Majesty, the fifth King of Bhutan, Jigme Khesar Namgyel Wangchuck put forth the idea of creating the Bhutan Baccalaureate, as a holistic and transformative curriculum for sustainable development.
The idea of the Bhutan Baccalaureate was also conceived after a nationwide survey conducted in 2008–2009, where Bhutanese from all walks of life were asked, “What is it that their children want to learn?” The responses collected from the survey shaped the concept of “five areas of development” — the cornerstone of the curriculum.

The unique feature of the Bhutan Baccalaureate is how it views education as a holistic, interconnected process that goes far beyond acquiring knowledge. The different areas of development and subjects taught often overlap with one another to break students and teachers out of the mentality of learning things in the silos of disciplines. The five areas of development ensure students grow to become well-rounded citizens, beyond just acquiring knowledge and vocational competencies.

The Bhutan Baccalaureate framework was conceived in consultation with the Department of Education at Oxford University, looking at philosophy, assessment and the learning process. The Royal Academy Learning Framework, 2020 was a key output of the development process, anchoring the whole teaching and learning curriculum.
Sustainability in the different areas of development

Teaching and learning within the Bhutan Baccalaureate often intersect across the five areas of development, and across disciplines. We take a brief look at how a sustainability-driven curriculum is exacted in the cerebral, social and emotional areas of development.

1. FOCUS ON COMMUNITY LEARNING

Seeing individual aspirations as separate from the aspirations of the community hinders individual ability to flourish and develop. The Bhutan Baccalaureate shifted its learning process from one that was learner-centred to one that was community-centred, to facilitate changing individual goals in tandem with shifting community needs. The curriculum does this in three ways:

The Seven Gifts

Each year, all students gather the “seven gifts” from their communities, which include language, songs, dances, stories, recipes and indigenous games. This event helps students connect to their history and pave a road for the future by understanding their heritage.

- Participation in local festivals
  Students assist to host important cultural festivals for the community, and in participating, contribute to their own spiritual and cultural growth.

- Planting and harvesting with farmers
  Students actively participate in local farming activities, allowing them to monitor the development of crops and assess the benefits and drawbacks of using synthetic versus organic fertilisers.

Did you know

Bhutan is a small, landlocked kingdom in South Asia that has a unique sustainability philosophy.

A few interesting facts about the kingdom:

- Gross National Happiness (GNH) was invented as a measure of national development, to balance popular metrics such as gross domestic product (GDP). The GNH places equal weight on good governance, environmental protection, cultural preservation and economic growth.

- It is the only carbon-negative nation in the world, owing to its generous preservation of forests to act as a carbon sink (almost 70% of total land). Almost all the electricity in Bhutan comes from hydropower. It has a high-value, low-impact philosophy towards tourism. All visitors pay a minimum daily charge to cover basic living necessities and tour guide fees.

- There are strict laws to protect the local wildlife, including the endangered species of snow leopard, Bengal tiger and black-necked crane. The nation is devoted to transitioning to 100% organic farming.

Participation in local festivals

 Students assist to host important cultural festivals for the community, and in participating, contribute to their own spiritual and cultural growth.

Planting and harvesting with farmers

Students actively participate in local farming activities, allowing them to monitor the development of crops and assess the benefits and drawbacks of using synthetic versus organic fertilisers.
2. EMPHASIS ON EMOTIONAL DEVELOPMENT

Students are encouraged to pay attention to their feelings and be conscious of how their feelings impact the other areas of development. There are four components in the emotional development curriculum:

- Awareness
- Recognition & articulation
- Identification
- Acceptance & positive regulation

3. PEOPLE, NATURE AND SOCIAL DEVELOPMENT

The social development area enables students to recognise themselves as healthy citizens that can contribute to society. Driglam Namzha is the Bhutanese code of etiquette that describes how a person interacts with their community and perceives themselves through thought, speech and action. The three main ideas of the social development curriculum are:

- **Community learning**
  Students are given a chance to show social responsibility. During the “seven gifts” programme, students interact with various members of the community, from parents to specialists.

- **Understanding oneself and others**
  Students are given chances to comprehend themselves and others through peer-mentorship and opportunities for leadership.

4. LIFE SCIENCES IN CEREBRAL DEVELOPMENT

Life science is one of the seven learning domains in the area of cerebral development. The Life Science curriculum offers a distinct viewpoint that transcends conventional and limited knowledge of a given domain. To build a comprehensive and critical understanding of natural and human processes, it integrates a variety of concepts from Chemistry, Physics, Biology, History, Geography, Economics and Environmental Science into one cohesive whole.

Through inquiry, the study of Life Science strives to help students to gain knowledge and understanding that is rationally and empirically justified, grasp how it interacts with society, and become aware of how it affects the environment.

While working with specific domain content, the following set of abilities will be used to develop knowledge:

- Rational inquiry
- Engaging with data and statistics (quantitative and qualitative)
- Multi-causal explanations
- Plurality of perspectives and the appreciation of diversity
- Bias and objectivity

The domain integrates ideas from the natural and social sciences to help students develop critical thinking and inquiry skills, as well as appreciate a world that is always changing.
Understanding sustainability, the environment and community through a gallery walk

As the Bhutan Baccalaureate is a new educational system, teachers are guided on how to carry out lessons that integrate concepts across multiple subjects and disciplines. For this particular lesson plan, Mr Thinley guides us through making use of a gallery walk as the main strategy to facilitate a class discussion for three different subjects (English, Geography and History) cutting across the three broad pillars of the Bhutan Baccalaureate (sustainability, the environment and community) for an integrated lesson on achieving local sustainability practices.

Desired learning outcomes and curriculum objectives

The main topics covered in this lesson are:

1. **Sustainability**
   
   Sustainability education aims to support the creation of a more sustainable world by educating individuals and communities to make intelligent decisions and take actions that consider the long-term effects on the environment, society and economy.

   The Bhutan Baccalaureate in general focuses on the following Sustainable Development Goals (SDGs):

   4. Quality Education
   11. Sustainable Cities and Communities
   12. Responsible Consumption and Production
   13. Climate Action

2. **The environment**

   Environmental education is vital for developing the critical thinking and problem-solving abilities required to handle complex environmental challenges, as well as for building a more environmentally-conscious and responsible society.

   Four pillars of the Gross National Happiness metric form the basis of Bhutan’s approach to holistic and sustainable development, which emphasises the importance of balancing economic growth with social and environmental well-being, while also preserving cultural heritage and promoting good governance.

   - **Sustainable and Equitable Socio-economic Development**
     - Quality of social service
     - Identifying areas to be developed
     - Free healthcare & education

   - **Environment Preservation**
     - 51% protected area
     - 71% forest cover
     - Waste management, pollution, recycling and other related areas

   - **Good Governance**
     - Decentralisation of policies
     - Transparent process
     - Serve with integrity, accountability

   - **Promotion of Culture**
     - Strong sense of identity
     - Social security net
     - Preserve social bonds

3. **Community**

   Community-centric learning is a key component in the Bhutan Baccalaureate. Community involvement in education is critical for supporting schools and teachers — bringing varied viewpoints and experiences; enhancing student engagement and motivation; encouraging innovation and collaboration; and relating classroom learning to real-world experiences and challenges.
KNOWLEDGE

By using this lesson, teachers should impart in students these knowledge dimensions:

**Knowledge**

**SUSTAINABILITY COMPONENT**

Students will be able to synthesise the three dimensions of sustainable development and the SDGs.

**ENVIRONMENTAL COMPONENT**

Students will be able to analyse the causes and consequences of environmental degradation, including human activities and climate change.

**COMMUNITY COMPONENT**

Students will be able to assess environmental policies, regulations and practices in their community, and identify opportunities for improvement and innovations.

**Reason**

Students can gain a deeper comprehension of the universal issues the world is experiencing through the SDGs.

Students discover how different systems interact and how living and non-living objects are interconnected.

Students understand the problems in their community, gain knowledge of democratic procedures, and build the capacity to become change agents.

**SKILLS**

Through the lesson, students will develop the following skills:

**SUSTAINABILITY COMPONENT**

Students will be able to present sustainable design proposals for their school, incorporating principles of renewable energy, conservation and waste reduction.

**ENVIRONMENTAL COMPONENT**

Students will be able to design posters to advocate against environmental degradation, take action for environment protection, and educate for climate-readiness.

**COMMUNITY COMPONENT**

Students will be able to create a strategy for the community and the school to stay updated with the practices, regulations, policies and innovations for sustainability and environmental issues.

**VALUES**

By the end of the lesson, students cultivate the following values:

**SUSTAINABILITY COMPONENT**

Students will be able to appreciate the health of the planet and all its inhabitants by being global citizens.

**ENVIRONMENTAL COMPONENT**

Students will be able to empathise with people and relate to the natural environment locally and globally.

**COMMUNITY COMPONENT**

Students will be able to develop leadership skills and a sense of responsibility towards their community.
Description of the lesson

The teacher first introduces the various components of the Bhutan Baccalaureate and gets students familiar with the three pillars of sustainability, the environment and community.

The teacher also goes through the Gross National Happiness metric and how it relates to the new curriculum.

The teacher goes through the Gross National Happiness metric and how it relates to the new curriculum.

The groupings in Mr Thinley's class were:

**English Group**

**SUSTAINABILITY COMPONENT**

Student teachers are to develop a proposal related to the sustainable design of their school, incorporating principles of renewable energy, conservation and waste reduction. They present their ideas on a poster.

**Resource**

- Urbanisation, carbon neutrality and Gross National Happiness: Sustainable development pathways for Bhutan (Kamei et al., 2021)
- A Systematic Study of Sustainable Development Goal (SDG) Interactions (Pradhan et al., 2017)

**Reason for assignment**

The English group is assigned the topic of sustainability as the task does not require much technical background. In Bhutan's education system, the tenets of sustainable development, including renewable energy, conservation and waste reduction, are imparted to children from an early age through formal education systems.
**Geography Group**

**ENVIRONMENT COMPONENT**

Student teachers are to discuss the causes and consequences of environment degradation, human involvement and climate change in their locality. They are tasked to design two posters that can be used for advocacy against environmental degradation and climate change for their schools.

**Resources**
- *Climatic changes and their impact on socio-economic sectors in the Bhutan Himalayas: An implementation strategy* (Hoy et al., 2016)
- *Strategies for mitigation of climate change: A review* (Fawzy et al., 2020)

**Reason for assignment**
Student teachers in the Geography group have technical knowledge in physical and human geography. The reading materials include technical issues relevant to their field of study.

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**History Group**

**COMMUNITY COMPONENT**

Student teachers identify challenges and opportunities to sustainable development and environmental issues in their community, with regard to existing policies, regulations, and practices. They will strategise ways to share innovative practices between the school and community, and present their strategies on a poster.

**Resources**

**Reason for assignment**
History students are interested in both past and contemporary human views. They are aware of the community's political systems.

---

After completing their assignments, student teachers put their outputs up on display around the classroom. They then commence the gallery walk, where they observe what the other groups’ outputs are.
As the student teachers bring this activity to their classroom and guide the students through it, they should:

**GROUP DEBRIEF**

**MONITOR PROGRESS**
The teacher should monitor students’ interaction with the exhibits and guide their interactions as needed.

**ENCOURAGE DIALOGUE AND REFLECTION**
While students tour the exhibits, the teacher can pose questions and stimulate reflection on the topic.

**GIVE FEEDBACK**
The teacher can remark on the work of certain groups, and student participation.

Students will be instructed to take notes and engage in dialogue with their group members on the posters. They will also note down observations and feedback to their peers.

After everyone has seen the outputs of other groups and shared their perspectives, the lead teacher debriefs the groups together with the following steps:

**STEP 1**
**Summarise the activity**

**STEP 2**
**Use open-ended questions to encourage discussion among the class about the exercise.**
For example:
a. What did you learn from the gallery walk?
b. What about the exhibits surprised you?
c. How can you use what you have learnt in your personal or professional life?

**STEP 3**
**Ask questions related to the topic.**
For example:
a. What are some of the challenges faced in achieving sustainability in your community?
b. How do global issues like climate change affect your locality?
c. How can the local community’s practice be contextualised in other countries?

**STEP 4**
Encourage student teachers to take part in debates and discussions with their peers, and encourage them to express their opinions on the topics discussed.

**STEP 5**
Give the class feedback on how they performed and urge peers to offer their feedback as well.
### ASSESSMENT

The activity is assessed using the following rubrics:

<table>
<thead>
<tr>
<th>Category</th>
<th>SCORE 20</th>
<th>SCORE 15</th>
<th>SCORE 10</th>
<th>SCORE 0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collaboration</td>
<td>Group worked really well together. Roles and duties were divided readily and evenly. Group members carried out roles to the benefit of the group, aiding one another, as necessary, to complete the task.</td>
<td>Groups worked together with almost no problems. Roles were divided evenly. Group members carried out roles with few problems. Group members aided one another to complete the task.</td>
<td>Group worked together some of the time. Roles were divided but carried out somewhat unevenly. Group members stuck to their own roles exclusively and rarely aided one another.</td>
<td>Group failed to work together to complete the task. Workload and roles were allotted to and carried out by few or no group members. Group members failed to aid one another in completing the task.</td>
</tr>
<tr>
<td>Time management and on-task behaviour</td>
<td>Group finished on time and members stayed focused on the task for the entire class period.</td>
<td>Group finished on time and members stayed focused on the task the entire class period with few distractions.</td>
<td>Group finished on time and members stayed focused on the task the entire class period with noticeable distractions.</td>
<td>Group failed to complete the task and members failed to stay on task most of the time with huge distractions.</td>
</tr>
<tr>
<td>Poster appearance</td>
<td>Poster reflected serious effort, was engaging and drew the eye of teachers and friends. At least 60% of the poster was non-textual. The text on the poster was easily read from a reasonable distance.</td>
<td>Poster reflected the effort and was somewhat engaging. At least 60% of the poster was non-textual. Most of the text on the poster was easily read from a reasonable distance.</td>
<td>Poster reflected some of the efforts but was not engaging to peers or teachers. At least 30% of the poster area was non-textual. Some text was easily read from a reasonable distance.</td>
<td>Poster reflected minimal or no effort and was not engaging. Less than 30% of the poster area was non-textual. Little text was legible.</td>
</tr>
<tr>
<td>Poster content</td>
<td>Content of the poster demonstrated advanced understanding of the topic addressed. Poster used proper content terminology/visuals related to topic addressed. Poster fully answered task's objectives using detailed information from the resources.</td>
<td>Content of the poster demonstrated a satisfactory understanding of the topic addressed. The poster used some proper content terminology/visuals related to the topic addressed. Poster satisfactorily answered task's objectives with information derived from the resources.</td>
<td>Content of the poster demonstrated some understanding of topic addressed. Poster used few appropriate terms/visuals related to topic addressed. Poster partially answered task's objectives with little information derived from resources.</td>
<td>Content of the poster demonstrated little or no understanding of the topic addressed. Poster used no appropriate terms/visuals related to topic. Poster failed to meet task's objectives.</td>
</tr>
<tr>
<td>Gallery walk answers</td>
<td>Group answered each question fully for each poster, using complete sentences. Answers demonstrated careful analysis of peers/posters. Group raised at least 2 significant questions per poster.</td>
<td>Group answered each question in a basic manner, using complete sentences. Answers demonstrated a basic analysis of peers/posters. The group raised at least 1 question per poster.</td>
<td>Group answered all questions in a basic manner, but failed to use complete sentences. Answers demonstrated a superficial analysis of peers/posters. Group raised at least 1 question for most of the posters.</td>
<td>Group failed to answer all questions and did not use full sentences. Answers given failed to demonstrate analysis of peers/posters. Group failed to raise questions for most of the posters.</td>
</tr>
</tbody>
</table>
Challenges and solutions in lesson implementation

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Potential solution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>THE INTERDISCIPLINARY CURRICULUM</strong></td>
<td>The lead facilitator needs to be clear on lesson goals, and direct conversations in a manner that these goals are met. It is helpful to lay out goals from each discipline before the lesson.</td>
</tr>
<tr>
<td><strong>THE DEPTH OF KNOWLEDGE REQUIRED</strong></td>
<td>Apart from providing reading resources, the lead facilitator can arrange for local community leaders to come to the school for a talk and share policy initiatives.</td>
</tr>
</tbody>
</table>

After the gallery walk exercise, student teachers are asked to write a reflection about their experiences, to help them process what they observed during the session. Some guiding questions are:

- Decide on meaningful steps you can take to promote environmental protection in your community and beyond, as well as in your daily life.
- Consider how your understanding of sustainability issues in your community has changed after this exercise, and how you may implement more sustainable habits in your personal life.
- Evaluate how crucial it is to establish strong relations with the people in your community, and consider how you might help.

Teacher’s reflections on the lesson

These concepts on which the Bhutan Baccalaureate was built upon are crucial for teachers to understand, as teachers will be the flag-bearers of the new education system that develops contributory citizens who are aware of both community-level and global issues.

There are a variety of effective teaching methods in higher education, and the most effective strategy will rely on the course material, the learning objectives and the student’s requirements and preferences. However, non-conventional teaching strategies like flipped learning, active learning and collaborative learning can be effective alternatives to traditional methods of teaching like the lecture method. This is particularly relevant in a higher education setting with diverse subject backgrounds.

The gallery walk can be one such teaching strategy that will be of ultimate advantage in higher education as it can contribute to the development of a more interactive and engaging learning environment that fosters critical thinking, collaboration and active learning.

While getting to understand the lesson objective and the task will not be a problem in the higher education setting, it will be challenging for the tutor to facilitate collaboration amongst different groups. Nevertheless, these shortcomings can be avoided by giving out proper instructions and promoting interest groups. A clear assessment criterion and use of a rubric can guide the students to be aligned with the lesson objectives. It can also be followed up through reflective writings.

- Mr Thinley Wangchuk

Teacher’s reflections on the lesson

• Decide on meaningful steps you can take to promote environmental protection in your community and beyond, as well as in your daily life.
• Consider how your understanding of sustainability issues in your community has changed after this exercise, and how you may implement more sustainable habits in your personal life.
• Evaluate how crucial it is to establish strong relations with the people in your community, and consider how you might help.

- Mr Thinley Wangchuk
Pedagogies that support learning about sustainable development

This section’s chapters focus on pedagogies that teachers can use to support Education for Sustainable Development (ESD). More importantly, they convey how important it is for teachers to carefully design and scaffold lessons. In general, a good lesson in ESD contains the following elements: (1) Direct relevance to students’ lives and contexts; (2) Opportunities for students to actively engage with the learning resources (rather than through didactic teaching); (3) Scaffolded tasks to guide students in making sense of the content; and (4) Opportunities for students to demonstrate mastery of knowledge, skills and values through the tasks.

Chapter 2.1 by Dr Tricia Seow, for instance, describes how gamification can transform an otherwise dry lesson on climate policies into an engaging, student-centred one. Here, students learn about Singapore’s policy options through gameplay. Instruction on specific policies after playing the game is based on students’ questions and needs, which are determined through a carefully scaffolded debriefing session. Similarly, in Chapter 2.3, Ms Honeylen Libunao approaches the issue of energy policy in the Philippines through the pedagogical device of a structured debate, thereby creating the means for students to actively engage with the materials and demonstrate their learning in a student-centred manner. Dr Stien J. Matakupan and Ms Ayuk Ratna Puspaningsih also tackle energy sustainability issues in Chapter 2.6, where students learn about indigenous methods to reduce fossil fuel consumption through interactive hands-on activities and the KWL technique.

The History and Social Science lessons designed by Ms Divine Mercy M. Go, Mr John Brian S. Molina, and Mr Domingo S. Adolfo, Jr. in Chapter 2.4, and the Ms Judy Sullano in Chapter 2.5, respectively, showcase the clever use of technology for learning. Applications like Quizizz, Google Jamboard and Pear Deck support both asynchronous and synchronous learning, allowing students to actively engage with the lesson materials, construct their own understandings, and demonstrate their learning. Dr Ho Huu Loc, Ms Sreejita Banerjee and Mr Hoang Minh Nguyen showcase how assessment tasks are relevant and meaningful through place-based learning in Chapter 2.2. In this example, students applied nature-based solutions to find the best fit for environmental problems caused by climate change in their home city of Can Tho, Vietnam.

This collection of lessons and pedagogies show how teachers in different subject areas can approach ESD to develop the knowledge and skills of an informed citizenry, however we want to define its scale. What these chapters further highlight is that in ESD, pathways for students to articulate or reflect on their individual and community values are also important. This is because our attitudes and values towards sustainability issues — beyond understanding and cognition — are the gateway to behavioural change and action.
The Sustainability Learning Lab (SLL) is a research and teaching centre situated within the National Institute of Education at Nanyang Technological University, Singapore. The SLL was set up with the aim to cultivate sustainability knowledge and foster adaptable and inclusive shared futures, through the following three core functions of the Lab:

2.1 Getting to Zero: A climate policy-based card game
Dr Tricia Seow

The Sustainability Learning Lab (SLL) is a research and teaching centre situated within the National Institute of Education at Nanyang Technological University, Singapore. The SLL was set up with the aim to cultivate sustainability knowledge and foster adaptable and inclusive shared futures, through the following three core functions of the Lab:

In this chapter, we learn:
- Basic principles of gamification
- Core climate policies affecting goal of achieving net-zero carbon emissions
- How to facilitate the Getting to Zero card game, to teach students big topics such as carbon policy

Gamifying carbon policy options
Gamification in education involves using game-like elements in instruction to increase student involvement and improve learning outcomes. Through this approach, an engaging student-centred environment is fostered so they feel comfortable engaging with big concepts.
Using principles of gamification, Getting to Zero is a physical card game conceptualised for secondary school Geography students in Singapore, to teach students about Singapore’s climate policy options. Originally conceptualised by colleagues Mr Eric Bae and Ms Melissa Low who work in environmental law and energy policy, respectively, the purpose behind the game is to help students understand the complexities and trade-offs in selecting climate policies to reduce carbon emissions in a fun and engaging manner. They approached the National Institute of Education (NIE) for feedback on developing the game for schools, and subsequently then-NIE student Ms Ng Wen Xin, redesigned the game.

The SLL at NIE undertook the work of researching the affordances of gamification and developing lesson resources around the game, which are aligned to the secondary and primary school syllabuses. It is hoped that students who play the game will engage cognitively and emotionally, enhancing learning and understanding of climate policy issues.

Some carbon policy cards in the deck

The game consists of elements such as game cards, game currency and a scoring sheet for competitive gameplay. Student players will be presented with a slew of anthropogenic (human-induced) activities with varying carbon footprints (e.g., deforestation, coal mining). The player who has expended the least amount of financial resources to ensure the lowest level of emissions wins the game.

How difficult is it for a nation to achieve its net-zero carbon goals?

SINGAPORE’S CLIMATE POLICIES

In 2016, Singapore launched its Climate Action Plan detailing its strategies to adapt to the impact of climate change, such as implementing coastal and infrastructure protection measures. The plan also explains the nation’s approach to reduce carbon emissions till 2030, which includes: (i) improving energy efficiency; (ii) reducing carbon emissions from power generation; (iii) developing cutting-edge low-carbon technologies; and (iv) responding through the collective action of government agencies, individuals, businesses and the community.

More recently Singapore has raised its national climate target to achieve net-zero emissions by 2050, and reduce emissions to around 60 MtCO2e in 2030 after peaking emissions earlier.

Did you know

Net-zero refers to the balance between the amount of greenhouse gas (GHG) that is produced and the amount that is removed from the atmosphere. It can be achieved through a combination of emission reduction and emission removal. It is not the same as being carbon neutral.

Carbon neutral is an ambition to limit any increase in future carbon emissions, while using offsets to neutralise existing emissions. Net-zero on the other hand places much more focus on reducing carbon emissions as much as possible first, and only offsetting unavoidable, residual CO2 as a last resort.
Facilitating a Getting to Zero game

The game is suitable for a minimum of five and a maximum of seven players. Teachers act as facilitators of the game and encourage students to reflect critically on their chosen actions.

Through playing the game, students will become familiar with the following key concepts:

**NET-ZERO (CARBON) EMISSIONS**
This refers to achieving an overall balance between greenhouse gas emissions produced and the amount removed from the atmosphere.

**CLIMATE POLICY OPTIONS**
Students get to learn about the different policies available and enacted to reach net-zero emissions.

**TRADE-OFFS**
How does one select policy options that bring down carbon emissions, while ensuring a competitive national economy?

Desired learning outcomes and lesson objectives

**KNOWLEDGE AND SKILLS**
From this card game, students will be able to gain the following knowledge and skills:

<table>
<thead>
<tr>
<th>Knowledge and skills</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Select and explain at least two climate policy options that are relevant for their own country (at the state/city/town level).</td>
<td>It is important for students to be aware of available climate policies to reach the goal of net-zero emissions, which is critical in mitigating climate change at a global level.</td>
</tr>
<tr>
<td>Understand and communicate the advantages and trade-offs involved in implementing various policies aimed at achieving net-zero climate emissions.</td>
<td>Students need to develop higher-order skills to evaluate, select and justify the best policies for their own contexts.</td>
</tr>
</tbody>
</table>

**VALUES**
Through the lesson, students will cultivate the following values:

<table>
<thead>
<tr>
<th>Values</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>SELF-EMPOWERMENT AND SELF-EXPRESSION</td>
<td>Individuals have a big role to play in mitigating climate change, and it is important to connect the policies to the students' own lives.</td>
</tr>
<tr>
<td>Students feel comfortable voicing how they can make a difference to their selected policy options.</td>
<td></td>
</tr>
</tbody>
</table>

SCAN TO READ
the complete Getting to Zero lesson package, game rules and facilitation prompts
Playing and facilitating a game with students

INTRODUCTION

The teacher introduces the game and the rules. Students are allocated into groups of four or five, and are allowed to clarify any doubts about the game.

Welcome to Getting to Zero!

This game is about understanding measures Singapore can implement to get us towards net-zero greenhouse gas (GHG) emissions.

Net zero refers to the balance between the amount of greenhouse gas produced and the amount removed from the atmosphere.

How to Play

You have been appointed by the government to lead the nation's sustainability efforts. You will be enacting a series of climate policies, and your goal is to reduce Singapore's GHG emissions as much as possible while ensuring a competitive economy.

You start with 50 and 50.

Some examples of climate policy cards:

- Fossil Fuel Usage
- Reforestation

The game takes place over 3 rounds.

Before the start of every round:

1. Shuffle all the cards well and deal the following, depending on the number of players:
   - 3 players: 9 cards/player
   - 4 players: 8 cards/player
   - 5 players: 7 cards/player

2. Place the remaining cards in a pile face-down in the centre of the playing area.

AND THE WINNER IS...

- Whoever has the greatest reduction in emissions wins!
- If multiple players tie for reduction in emissions, the player with the most money wins.
The game starts. Students proceed to play the card game and the teacher plays the role of the main facilitator while looking out for common misconceptions the students may have. The teacher could quickly document parts of the game-play (e.g., actions taken, consequences) on the white board for a debrief later.

The game starts. Students proceed to play the card game and the teacher plays the role of the main facilitator while looking out for common misconceptions the students may have. The teacher could quickly document parts of the game-play (e.g., actions taken, consequences) on the white board for a debrief later.

### Gameplay

**Starting a round:**
1. To start a round, all players simultaneously choose 1 card from their hands that they would like to keep and place it face-down in front of them.
2. When every player has done this, everyone reveals their chosen cards.

**At the end of every round:**
1. Tabulate the reduction in emissions and how much money you have left.
2. Use the scoresheet to keep score (one player would be the scorekeeper).

*Special rule ONLY at the end of Round 1*

The player with the most $1000 at the end of Round 1 will be awarded a bonus of 10 $100.

1. Discard all your cards EXCEPT pangolin cards*, which you will keep in front of you. They will to be scored at the end of the game.

Students are introduced to the policies and economic trade-offs through the gameplay, which is the basis for their discussion and evaluations later. This is more engaging than being introduced to the policies via a lecture.

---

**How to Play**

Starting a round:
3. After revealing cards, pass the remaining hand face-down to the player on your left. Everyone picks up their new hands and the next turn begins.
4. The round ends when the final remaining card of each hand is passed on.

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OTTER

Being killed by another otter in a Singapore's National Park costs 40 $100.

End of Round 1

---

PANGOLIN

End of Round 1

---

**Students are introduced to the policies and economic trade-offs through the gameplay, which is the basis for their discussion and evaluations later. This is more engaging than being introduced to the policies via a lecture.**
After the game has ended, it is important to consolidate the big ideas that underpin the game, especially the climate policy options and the trade-offs involved. These include:

- Explanation of the key climate policy options that are relevant to context, or that students are particularly interested in.
- The trade-offs (usually based on a cost-benefit analysis in economic terms) involved in the quest for net-zero greenhouse gas emissions.

Explain policies that the teacher feels students need a deeper understanding of, and the rationale behind the card “prices”.

The teacher also facilitates discussions on the policies that students think are most relevant to their context.

Facilitation prompts can include:

**Prompts related to the gameplay:**

- Which climate policies do you think Singapore has implemented?
- What is one card/policy that was the most memorable to you? Why?

**Prompts related to taking action:**

- What is one hope that you have for your community when it comes to taking climate action?
- What role do you think you can play in taking action for the climate in your community?

**Prompts related to specific cards:**

- What are some policy limitations reflected in the cards?

There is limited potential. Due to geographical features, countries in ASEAN may have limitations on domestic grid connectivity between production and demand, e.g., Malaysia has its hydropower resources located on Borneo, which is not connected by land to Peninsular Malaysia.
Students are asked to think of two ways in which they can contribute to a climate policy they choose. This can then form the basis of the next lesson on taking action.

It is important to connect climate policies to the students’ lives, as these policies may seem abstract and irrelevant to them. Through understanding how they can be part of the solution, students are encouraged to see themselves as change agents to reach the goal for net-zero emissions.

**Challenge**

- Students may have difficulty understanding the game rules and playing the game at first.
- Some student groups are a bit shy in sharing their policy options and speaking up in class.
- Sometimes students play the game only to win and focus on the numbers on the cards, rather than learn about the policies.

**Potential solution**

- Using the “How To Play” slides, teachers can help students understand the game steps before starting the game.
- For new players, remove the power cards to simplify gameplay.
- “Train” one student per group on how to play the game before the lesson, so they can lead the group.
- A poll app like Mentimeter can be used to get students to vote for the policy that they feel is best for Singapore to get the students thinking. The teacher can then lead a discussion on why a particular strategy is popular or not popular, taking care to highlight the trade-offs and advantages of the strategy in context.
- During the debrief segment, the teacher needs to call attention to what the numbers mean in each policy, by asking students why they think a particular policy has been assigned a specific number in terms of changing carbon emissions and increasing costs.
As compared to more traditional modes of learning, learning through games has been deemed as being more appealing due to its novelty, ability to capture the imagination of players and its multi-sensory nature. However, the debrief is crucial. Teachers are indispensable in redirecting the students’ attention towards the fundamental big ideas that are woven into Getting to Zero, extending these ideas (for example, asking specific questions that help them to evaluate relevance of a selected policy to their specific context), and asking provocative questions that involve critical thinking about trade-offs.

When students are asked to think about their personal roles in mitigating climate change and getting to net-zero emissions, they may have trouble doing so. But these doubts can be the foundation of the next session where we discuss individual responsibility and collective action, perhaps even thinking of a class project that can take action in support of a climate policy.

- Dr Tricia Seow

Climate change has caused disruptions to the hydrological cycle and negatively impacted agriculture and livelihoods of communities within the Mekong River Basin. To mitigate these negative effects, communities can turn to nature-based solutions as a sustainable alternative to dams and other grey infrastructure, and ensure the continuation of thriving agricultural communities. Dr Loc and his team from the Asian Institute of Technology demonstrate how teachers in the Mekong River Basin can introduce the concept of nature-based solutions to students through place-based learning.

### 2.2 Understanding nature-based solutions through place-based learning

Dr Ho Huu Loc, Ms Sreejita Banerjee & Mr Hoang Minh Nguyen

Climate change has caused disruptions to the hydrological cycle and negatively impacted agriculture and livelihoods of communities within the Mekong River Basin. To mitigate these negative effects, communities can turn to nature-based solutions as a sustainable alternative to dams and other grey infrastructure, and ensure the continuation of thriving agricultural communities. Dr Loc and his team from the Asian Institute of Technology demonstrate how teachers in the Mekong River Basin can introduce the concept of nature-based solutions to students through place-based learning.

**In this chapter, we learn:**
- How climate change has affected lives in the Mekong River Basin
- What nature-based solutions are and how they can address environmental challenges induced by climate change
- How students can learn about the appropriate nature-based solutions for Can Tho city in Vietnam through place-based learning

**Try it out!**

Creating a game from scratch requires much effort and time — resources that busy teachers may not be able to commit. However, aspects of gamification, such as having a point system, can still be incorporated into the classroom. What are some elements of gamification that can be included in your next lesson?
In the Lower Mekong region, climate change compounds existing and projected threats affecting the region’s people, biodiversity and natural resources. This is anticipated to have a cascading effect, such as a shortage of water causing a decline in crop productivity. Prolonged and erratic droughts are predicted to be more frequent, resulting in reduced water availability during the dry season.

The Mekong Delta, which covers an area of 40,000 square kilometres, is mostly situated less than 2 metres above the mean sea level, making it vulnerable to rising sea levels as a result of climate change. The delta region is facing a range of environmental challenges, including more frequent and severe floods, increasing risk of drought due to changes in rainfall patterns, over-extraction of groundwater, unsustainable sand mining for construction purposes, and rapid hydropower development in the upstream region further exacerbated by climate change impacts.

Climate change has led to more significant storms and inundation in the upstream provinces of the Mekong Delta; salt intrusion from the sea into rivers and canals have affected fisheries, agriculture and water supply; changes in temperature have increased environmental pollution directly impacting humans and aquaculture. For the region to adapt to increasingly frequent disruptions caused by climate change, there needs to be sustainable solutions that prioritise the well-being of the people while addressing climate change’s long-term impacts.

Nature-based solutions for sustainable development

According to the International Union for Conservation of Nature (IUCN), nature-based solutions (NBS) are:

“Actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously benefiting people and nature... [they] are underpinned by benefits that flow from healthy ecosystems.”

Some examples of NBS include restoration and protection of forests and different forms of wetlands, creation of green roofs and walls, planting of trees, and protection of coastal habitat. They work, for example, by conserving and rehabilitating forests and wetlands within the catchment areas to safeguard and regulate water supplies; promoting the production of forest products; and protecting communities and infrastructure from natural hazards like floods, soil erosion and landslides. Integrating nature in an urban setting by installing green roofs and walls and planting trees can help mitigate the effects of heatwaves, reduce environmental pollution and capture stormwater.
The use of any types of NBS needs to be tailored towards the specific environmental issues and the accompanying socio-economic challenges as there are no universal applications of NBS. For example, to improve food security in coastal areas of Bangladesh, multiple articles have suggested multi-trophic aquaculture practices such as prawn, fish and rice farming systems.7 For arid environments like southern Africa with limited access to artificial fertilisers, some authors highlighted the adoption of intercropping with fertiliser trees.8 For urban areas, practices like community gardens and green roofs are highly recommended.9 Students and applicants of NBS need to understand the different roles and importance of NBS and to identify the NBS practices that are appropriate for their community and specific environmental challenges.


Benjakitti Forest Park is part of the ‘Green Bangkok 2030’ initiative to enable a network of rich urban ecology

Image source: Supanut Arunoprayote

NBS as an example of sustainable development is an alternative to grey infrastructure. NBS utilise natural systems, such as mangroves, to protect water resources and reduce the impact of climate change. It is possible, however, to create hybrid solutions where NBS are used alongside grey infrastructure.

KEYWORDS

Grey infrastructure refers to man-made water structures constructed out of hard building materials like concrete, hence the “grey” in the name. Examples of grey infrastructure include dams and drains. While grey infrastructure is useful in mitigating the effects of climate change on water resources, nature-based solutions provide an environment-friendly alternative for sustainable environmental management.
Multiple local communities are potential prime targets for NBS applications throughout the Lower Mekong River Basin (LMRB). One notable example is the Mekong Delta, the most downstream region of the LMRB, situated almost entirely inside the southern region of Vietnam. Vietnam has been regarded as one of the developing countries most affected by climate change.\textsuperscript{10} The Delta is considered as the “rice bowl” of Vietnam, being responsible for the majority of the country’s food production and over four-fifths of its rice export.\textsuperscript{11}

Of the numerous environmental challenges to the future of food production within the Delta, changes in hydrological regimes such as rainfall intensity and patterns, and the rise in saline intrusion are the most challenging with significant potential to reduce the overall rice crop productivity.\textsuperscript{12} Given the dire need for mitigation and adaptation efforts to minimise future climate change effects without compromising the natural environment and food production output, the Mekong Delta is a prime location to implement NBS applications.

Multiple NBS might be applicable here but one example that has been studied extensively is \textit{rice-fish integrated agroecosystem}.\textsuperscript{13} Besides the increase in rice yield, farmers who apply this practice also gain aquaculture production and the combined benefits are significantly higher than ones from individual sources.\textsuperscript{14} This practice can also increase soil water storage capacity and hence, reduce the need for irrigated water resources, which are going to be limited under future climate change scenarios.

\begin{flushright}
![Farmers practise rice-fish farming, which promotes biodiversity and diversification](Image source: FAO/ Xaykhame Manlaisith)
\end{flushright}

\begin{center}
\textbf{Place-Based learning}
\end{center}

In the following lesson plan, Dr Loc and his team conceptualised a lesson using place-based learning to teach students about nature-based solutions, and the appropriate NBS for different communities along the Mekong Delta.

Place-based learning immerses students in local heritage, cultures, landscapes, opportunities and experiences, using these as a foundation for the study of language arts, mathematics, social studies, science and other subjects across the curriculum. It emphasises learning through participation in service projects for the local school and the community.

With the prior knowledge of their surrounding landscapes, culture and man-environment relationship, students will be able to associate new knowledge with their past experiences. This will give them a sense of belonging and help them to easily relate to the content, easing them into the use of new terminologies and theories.

Understanding nature-based solutions through place-based learning

Place-based learning allows students to learn about nature-based solutions specific to and appropriate for their locality. In this lesson plan, Dr Loc and his team walk us through what nature-based solutions are appropriate for the environmental challenges faced in Can Tho, a southern Vietnamese city sitting right at the Mekong Delta.

**Desired learning outcomes and lesson objectives**

The main topics covered in this lesson are:

- Understanding the social and environmental challenges in Can Tho city brought upon by climate change
- Understanding how nature-based solutions can reduce the impact of climate change on water resources
- Understanding how nature-based solutions are relevant and impactful to local communities in Can Tho city

**KNOWLEDGE AND SKILLS**

From the lesson, students will be able to gain the following knowledge and skills:

**Knowledge and Skills**

- Students will be able to understand and recall the definitions of NBS:
  - Understand and explain the keywords: sustainability, restore, ecosystem and biodiversity.
  - Understand and explain the environmental challenges faced by societies that can be addressed by NBS.

**Reasons**

- Getting to the concept of global climate change and how to combat its negative impacts through NBS is a key element in developing sustainability. Therefore, it is important to understand the issues and their resolutions from a holistic point of view.
- Students need to develop higher-order evaluative skills to evaluate, select and justify the best solutions at a local scale.

- Students will be able to understand and explain how NBS for climate change can help with sustainable development in their local communities.
VALUES
Through the lesson, students will cultivate the following values:

<table>
<thead>
<tr>
<th>Values</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>SELF-EMPOWERMENT AND RESPONSIBILITY TO COMMUNITY</td>
<td>Mitigating climate change effects should be seen as something that is not limited to only governments and companies. Individuals have the responsibility to do so as well, and it is important to help students identify and understand the different ways they can impact their community and combat climate change on a local level.</td>
</tr>
</tbody>
</table>

Conducting the lesson

LESSON 1
In previous lessons, the teacher would have covered key concepts on climate change and the hydrological cycle with their students. Making use of that prior knowledge, the teacher introduces in this lesson the effects of climate change on the Mekong River Basin, and the concept of nature-based solutions.

The teacher then broadly introduces four nature-based solutions to students. These will be elaborated on in the next lesson, as NBS that can address environmental challenges in Can Tho city.

1. CONTEXT AND PREPARATION

SUPPLEMENTARY RESOURCES FOR TEACHERS ON
climate change | the hydrological cycle

CLIMATE CHANGE IN THE MEKONG RIVER BASIN
Climate change affects people living in the Mekong River Basin
Asia’s Great Climate Frontiers: The Mekong Delta under threat

NATURE-BASED SOLUTIONS
What are nature-based solutions?

RICE-FISH CULTURE SYSTEM
From this lesson, students get introduced to the environmental challenges facing communities within the Mekong Delta at large, and understand the basic concepts of nature-based solutions with some examples of what they are.

Can Tho city is the largest city in the Mekong River Delta with an area of 1401 sq km (3.46% of the whole Mekong Delta) and a population of 1,171 million. Although Can Tho city is a rapidly developing urban centre, 65% of its population still live in rural and suburban districts and there is a significant proportion employed in the agriculture sector.
As the city is located in the middle of the delta, the city largely relies on water from the Mekong River for domestic use, industry, aquaculture and agricultural production. Rapid changes to the Mekong river’s hydrology due to climate change and urbanisation can therefore negatively impact the city’s livelihood and economic development.

**Environmental challenges arising from climate change**

The city is expected to experience rising temperatures and decreasing rainfall because of climate change effects. These, coupled with increasing number and size of upstream hydropower plants, are projected to reduce the quantity of water supplied by the Mekong river.

Another consequence is the rising salinity intrusion as there is less water to flush out the saltwater coming from the sea, which has also increased due to rising sea levels. Their combined impact is expected to reduce the rice paddy yield in all cultivation seasons by 2050. Moreover, the reduced water supply from the river will force people living in Can Tho to increasingly turn to groundwater, which has already been over-exploited and exposed to pollution from ground surface.

Students will be asked the questions:

1. How does climate change impact food availability in Can Tho city?
2. How does the change in food availability impact eating habits?
3. How does climate change affect occupations of people in Can Tho city?

The teacher then elaborates on the four nature-based solutions covered in lesson 1, demonstrating how they can be adapted to address the environmental challenges faced by Can Tho city. These are:

1. **The rice-fish culture system**

Rice-fish integrated agroecosystem (or rice-fish culture) is the agricultural practice in which fish are grown together or alternately with rice in a rice paddy.\(^{15}\)

In this system, fish of selected species and size are stocked to produce an additional source of income to the rice farmers whose main crop is rice. In addition to the benefits of dual food production, this system also lowers the need to supply artificial fertilisers as nutrients from fish food are recycled into the soil, and reduces the need for artificial pesticides as the fish feed on weeds and pests.

This NBS can help farmers in Can Tho city increase crop yield and diversify their income source, when rainfall and water supply become inconsistent.

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2. Green roofs

A green roof (or living roof) is a roof of a building that is partially or completely covered with vegetation and a growing medium, planted over a waterproofing membrane. It may also include additional layers such as a root barrier and drainage and irrigation systems.\(^\text{16}\)

The multiple benefits of green roofs include: 1) Reduction in heat intensity in inner city and therefore, reduction in energy demand; 2) Reduction of air and noise pollution; 3) Reduction in quantity and increase in quality of stormwater; 4) Increase in local food production (urban agriculture); and 5) Increase in urban biodiversity by providing support to vegetation growth and local pollinator population.\(^\text{17}\)

3. Agrotourism

Agrotourism is a form of business that connects agricultural production and tourism by attracting visitors to farms, ranches and other agricultural facilities. Besides economic gain, agrotourism can be of educational purpose in which visitors are to familiarise with agricultural practices and production.\(^\text{17}\)

Benefits of agrotourism include: 1) More stable and higher income by providing supplemental economic resources to farmers while maintaining a primary focus on agriculture production; 2) Increasing the livelihood of farmers, especially during economic downturn or off-season; and 3) Taking advantage of local resources such as available facilities, landscape and labour.\(^\text{18}\)
4. Agroforestry

Agroforestry is the agricultural practice in which trees and shrubs are grown together with crops and/or animal husbandry to create environmental, economic and social benefits. Beneath the trees, farmers can grow pasture for animal grazing or cash crops.\textsuperscript{19}

Agroforestry offers support for food production while reducing the negative impact of modern agriculture such as soil erosion and water pollution by establishing a barrier between the field and surface water resources, and biodiversity loss by increasing habitat for native wildlife. Specific tree species have also been found to be natural resources of fertilisers and salt absorption.

\textsuperscript{18} PR Nair, An Introduction to Agroforestry (Springer Science & Business Media, 1993).

Example of growing pineapple together with coconut trees in Kien Giang province, Vietnam

Image source: Thanh ninh Vietnam

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**Lesson 3**

Students are divided into small groups of not more than five, inclusive of both high and low achievers.

Each group will be asked to prepare a presentation on an environmental challenge in Can Tho city, and explain what they think is an appropriate NBS to address this challenge. They are instructed to:

1. Choose one environmental challenge arising from climate change from Can Tho city (rising temperatures, rising sea levels, animal/plant extinction, etc.) based on their knowledge from the previous class. They are asked to supplement this knowledge with further research on the causes of the environmental challenge.

2. Select an appropriate NBS for that particular threat and explain how it can mitigate the negative effects of this climate change-induced challenge.

3. Explain how their chosen NBS can be adapted to be implemented at a local scale.
<table>
<thead>
<tr>
<th>Parameters/ Scale</th>
<th>Needs improvement</th>
<th>Satisfactory</th>
<th>Good</th>
<th>Excellent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Understanding of new knowledge</strong></td>
<td>Shows little understanding of the challenges faced, and provides no relevant evidence to support this.</td>
<td>Shows little understanding of the challenges faced, and provides no relevant evidence to support this.</td>
<td>Shows good and generally accurate understanding of the challenges, and provides some relevant evidence to support this.</td>
<td>Shows deep and accurate understanding of the challenges faced, and provides relevant evidence to support this.</td>
</tr>
<tr>
<td>i. Identification of the environmental challenge with proper justification.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ii. Plan the implementation of the NBS to combat the problem.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Application of knowledge/ skills</strong></td>
<td>The suggested NBS is not relevant to the challenge or to the context, and the implementation plan requires complete modification.</td>
<td>The suggested NBS is mostly not relevant to the challenge and/or to the context, and the implementation plan requires major modification.</td>
<td>The suggested NBS is somewhat relevant to the challenge and to the context, and the implementation plan is feasible with some modification.</td>
<td>The suggested NBS is highly relevant to the challenge and to the context, and the implementation plan is highly feasible with no or minor modification.</td>
</tr>
<tr>
<td>i. Design appropriate NBS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ii. Plan the implementation of the NBS to combat the problem.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Collaboration</strong></td>
<td>Not an active contributor or collaborative learner. Does not share ideas, or ideas are not constructive and appropriate.</td>
<td>Sometimes active contributor and collaborative learner. Is only occasionally forthcoming in sharing ideas, though not all are constructive and appropriate.</td>
<td>Generally active contributor and collaborative learner. Is usually forthcoming in sharing ideas which are mostly constructive and appropriate.</td>
<td>Consistently active contributor and collaborative learner. Is always forthcoming in sharing ideas which are constructive and appropriate.</td>
</tr>
</tbody>
</table>

| **Contribution to feedback** | Does not ask questions and does not provide feedback during discussions. Is unable to respond to others’ feedback in a constructive manner. | Is not usually able to ask relevant questions, or provide constructive feedback. Is only occasionally able to respond to others’ feedback in a constructive manner. | Is usually able to ask relevant questions, or provide constructive feedback during discussions. Is usually able to respond to others’ feedback, though not always in a constructive manner. | Is always able to ask very relevant questions, and provide highly constructive feedback during discussions. Is always able to respond to others’ feedback in a constructive manner. |

ASSESSMENT
A rubric will be provided to them beforehand to help them to understand the parameters.
The students proceed to present their ideas while the teacher plays the role of the main facilitator, keeping a look out for common misconceptions about NBS that students may have. The teacher could quickly document parts of the discussion (e.g., actions taken, consequences) on the white board for a debrief later.

During the presentations, observing students are guided to provide critical feedback using the 3-2-1 approach:

1. Identify 1 recommendation to the presenting group
2. Identify 2 things that can be improved from the presentation
3. Address 3 key learning points from the presentation

To guide students on giving constructive feedback, the teacher can get students to keep in mind the following questions as they listen to the presentations:

- Is the solution relevant for the place/context?
- Is the solution easy or feasible to implement?
- How does the chosen NBS benefit the community?
- Are there ways to improve on the solution?

### Potential challenges during the implementation of the activity

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Potential solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students may struggle to understand the objective of the activity, or what is expected of them.</td>
<td>Teachers can provide students with a rubric to guide students' brainstorming. A detailed account of all the components expected in the discussion can also be provided.</td>
</tr>
<tr>
<td>Students can have difficulty in finding materials.</td>
<td>Teachers can provide students with a list of curated resources to start them off, and guide them on how to choose reliable and diverse sources.</td>
</tr>
</tbody>
</table>
2.3
Debating renewable energy
Ms Honeylen Libunao

Unlike subjects such as STEM or Geography where the link between sustainability principles and scientific or geographical concepts is easily established, one might not immediately see how sustainability concepts can be applied in a language arts classroom. However, language lessons offer the dual affordances of language mastery while using language as a medium to discuss ideas in sustainability. English teacher Ms Honeylen Libunao demonstrates a unique way of teaching her students about renewable energy, through coordinating lessons with their science teacher and deepening their content mastery through debates.

In this chapter, we learn:
- What a debate is and how an Asian parliamentary-style debate is conducted
- How to carry out an English language curriculum focusing on learning debate skills
- How to encourage cross-disciplinary learning through coordinating with a Science class, to centre a debate around renewable energy

Renewable or Non-Renewable, that is the question

Learning about sustainability concepts does not have to be confined to Science and Geography classes; it is very possible for language and humanities teachers to engage students meaningfully with these concepts while using the topic to hone students’ language skills. Ms Honeylen crafted a single-term curriculum for her English class around learning the Asian parliamentary debate style and persuasive skills, choosing renewable energy as the topic of her debate.

In a joint cross-disciplinary effort, she collaborated with the Science teacher for her class to coordinate their learning schedules, such that her students would have learnt the content knowledge about renewable energy during Science lessons, while concurrently learning persuasive writing and debate techniques in her class. The term culminated in a unique debate session according to the Asian parliamentary debate format, where students debated the use of renewable energy in the Philippines representing motions for and against the topic.

Ms Honeylen’s English curriculum presents a unique way for students to engage with the scientific knowledge of sustainability topics, and apply that knowledge in a debate session that hones their language and critical thinking skills. Through this joint activity, students feel empowered to take action for sustainable living through mastering both the scientific background of renewable energy and critical persuasion skills for implementing change.
Renewable energy policy in the Philippines

The Philippines has enacted several policies to promote the development and use of renewable energy. Some of these policies include:

Renewable Energy Act of 2008: This law provides a framework for the development and promotion of renewable energy sources such as biomass, wind, solar, and hydropower. It mandates that all electric utilities source a portion of their energy from renewable sources, with a target of 35% of the country’s electricity generation to come from renewable sources by 2030.

Net Metering Scheme: The scheme allows consumers who generate their own renewable energy to sell excess energy back to the grid. This incentivises the adoption of renewable energy technologies such as rooftop solar panels.

Feed-in-Tariff (FIT) System: The FIT system provides guaranteed payments to renewable energy producers for a fixed period, encouraging investment in renewable energy projects. The Philippines has implemented a FIT system for solar, wind, biomass and hydroelectric projects since 2012.

Green Energy Option Program (GEOP): The GEOP enables consumers to choose to source their electricity exclusively from renewable energy sources by entering into a contract with a renewable energy provider.

Renewable Portfolio Standards (RPS): The RPS mandates that a certain percentage of electricity generation come from renewable energy sources. The Philippines implemented an RPS in 2012, with a target of 10% of electricity generated to come from renewable sources by 2030.

These policies are aimed at promoting the use of renewable energy and reducing the country’s dependence on fossil fuels.

The Asian parliamentary debate style

A debate is a discussion on a topic between two opposing sides, and is a pedagogical tool popularly used in the language arts classroom. This is because the preparation and the execution of a debate promote receptive and productive language skill development, such as listening and speaking. Because a debate is highly structured and has its own rules, it is a useful tool to evaluate students’ listening, persuading, critical thinking and speaking skills.

In every debate, there is a central statement, or a motion, that the teams would either argue for or against.

Some examples of motions on renewable energy are:

- THBT the Bataan Nuclear Power Plant’s reactivation would solve the problem of unstable power supply in the country.
- THBT all nations have the right to own nuclear weapons.
- THBT coal power is still a better power supply for the Philippines than nuclear power.

Did you know

A motion often begins with “This house believes that...” which is shortened to “THBT”. Other commonly used alternatives include “This house supports...” or “This house would...” for different kinds of motions.

Food for thought

What are some renewable energy policies in your country? Do you know which renewable energy sources are suitable for your nation’s geography and context?
In an Asian parliamentary-style debate, the two teams are given the roles of the **government** and the **opposition**. The government team supports and defends the motion, while the opposition team refutes the motion. The three members in each team also have specific roles that determine the order in which they speak, the amount of time they are given to speak, and the types of arguments they can make:

**Government Team**

- **Prime Minister (PM)**
- **Deputy Prime Minister (DPM)**
- **Gov. Whip (GW)**

**Opposition Team**

- **Leader of Opp. (LO)**
- **Deputy Leader of Opp. (DLO)**
- **Opp. Whip (OW)**

**Podium**

- PM speaks for 7.5 mins
- LO speaks for 7.5 mins
- DPM speaks for 7.5 mins
- DLO speaks for 7.5 mins
- GW speaks for 7.5 mins
- OW speaks for 7.5 mins

**Format of an Asian parliamentary debate**

**Conducting a debate on renewable and non-renewable energy**

Debates can be enjoyed by and conducted for students from ages 11 onwards, with various debate topics and the post-debate discussions for different age groups. To reap the most benefits out of using debates in learning about sustainability, it is crucial to ensure that there is adequate scaffolding in terms of language support and content knowledge. This is best done over a period, for example, in a unit or a term.

The main topics covered in this lesson are:

**RENEWABLE AND NON-RENEWABLE ENERGY RESOURCES:**
- What are the renewable and non-renewable energy resources available? (covered in Science class)
- What are their advantages and disadvantages?
- How feasible is each energy source for use in the country?

**ARGUMENTATION**
- Fallacies
- Logical thinking

**SPEECHES**
- Impromptu
- Extemporaneous
- Mock debates

**DEBATE**
- Terms
- Associated debate skills
- Different debate formats
KNOWLEDGE AND SKILLS
From participating in the debates, students will be able to gain the following knowledge and skills:

Knowledge and skills | Reasons
--- | ---
Students will be able to demonstrate listening, persuading, critical thinking and speaking skills in a debate. | The skills of listening, persuading, critical thinking and speaking can be developed through debating. It is important also for students to learn how to express their thoughts on different issues in a clear and coherent manner.

VALUES
Through the lesson, students will cultivate the following values:

Values | Reasons
--- | ---
Respecting different opinions — students will be able to express their opinions clearly and respectfully, and respect others’ opinions too. Students will be able to have informed opinions on the most suitable energy sources for the country. | Students should learn the value of respectfully expressing their opinions and respecting those of others. The debate will also be an opportunity for them to weigh in on issues about sustainability beyond individual levels.

Tip
It is essential to approach sustainability topics in a cross-disciplinary manner, as many sustainability concerns are complex and cut across disciplines (e.g., Geography, Language, History, Policy, Science). To successfully conduct a cross-disciplinary class, content and skills need to be properly integrated and coordinated across subjects, such as in Ms Honeylen’s positive example here.
a. Familiarise students with the debate format
A week before the students began their debates, Ms Honeylen showed them samples of debate rounds in the Asian parliamentary style to familiarise them with its format.

b. Craft and curate the motions
To ensure the objectives of the activity is achieved, the motions must be carefully crafted by the teacher to balance a variety of perspectives.

Tip
As there are multiple groups per class, and not all rounds of debate may be accommodated over one period. The teacher should allow for ample time over multiple lessons for all groups to debate.

ASSIGNING GROUPS AND MOTIONS
On the day of the debates, Ms Honeylen divided the class into teams of three students each and had them draw lots to decide if they would debate on the government or the opposition side, before announcing and assigning the motions. The teams were then given five minutes to assign the speaker roles among themselves.

After the roles had been determined, Ms Honeylen did a recap of the mechanics of the debate format:

The motions crafted by Ms Honeylen on the topic of renewable energy are:

- THBT the Bataan Nuclear Power Plant’s reactivation would solve the problem of unstable power supply in the country.
- THBT all nations have the right to own nuclear weapons.
- THBT coal power is still a better power supply for the Philippines than nuclear power.
- THBT the Philippines’ use of renewable energy would be most beneficial and practical than coal power.
- THBT wind power source in the Philippines should be tapped more than our water power source.

Preparing for the debate
For the debaters: The Science teacher would provide the students relevant information about the topics such as policies on renewable resources, statistics on the use of renewable resources in the country, etc.

For the adjudicators: They are given the rubric used by the teacher to evaluate the debates. This way, they know the specific areas they could comment on. They are also briefed on how debates are usually evaluated.

The teams up for debate were chosen on the same day and given 15 minutes to prepare their speeches and arguments.

The Bataan Nuclear Power Plant and the coal-fired power plant in the Philippines
## ASSESSMENT
The rubric used in Ms Honeylen's class was:

<table>
<thead>
<tr>
<th>Criteria</th>
<th>4 Advanced</th>
<th>3 Proficient</th>
<th>2 Developing</th>
<th>1 Beginning</th>
<th>0 No inputs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Organisation/Clarity</strong></td>
<td>All arguments were clearly tied to an idea (premise) and organised in a tight and logical fashion.</td>
<td>Most arguments were clearly tied to an idea (premise) and organised in a tight and logical fashion.</td>
<td>Some arguments were clearly tied to an idea (premise) and organised in a tight and logical fashion.</td>
<td>Some arguments were not tied well to an idea and organisation of ideas was not much observed.</td>
<td>All arguments were not tied to a single idea and organisation of ideas was not at all observed.</td>
</tr>
<tr>
<td><strong>Use of Arguments</strong></td>
<td>All arguments were clear, accurate and thorough.</td>
<td>Most arguments were clear, accurate and thorough.</td>
<td>Some arguments had minor inaccuracies and were somewhat shallow.</td>
<td>Most of the arguments were unclear, inaccurate and shallow.</td>
<td>All of the arguments were unclear, inaccurate and shallow.</td>
</tr>
<tr>
<td><strong>Use of Facts/Statistics</strong></td>
<td>Every major point was well-supported with several relevant facts, statistics and/or examples.</td>
<td>Most of the major points were well-supported with several relevant facts, statistics and/or examples.</td>
<td>Some of the major points were not supported with relevant facts, statistics and/or examples.</td>
<td>Most of the major points were not supported by relevant facts, statistics and/or examples.</td>
<td>All major points were not supported by relevant facts, statistics and/or examples.</td>
</tr>
<tr>
<td><strong>Rebuttal</strong></td>
<td>All counter-arguments were precise, relevant and strong.</td>
<td>Most counter-arguments were precise, relevant and strong.</td>
<td>Some counter-arguments were weak and irrelevant.</td>
<td>Most counter-arguments were weak and irrelevant.</td>
<td>All counter-arguments were weak and irrelevant.</td>
</tr>
<tr>
<td><strong>Respect for Opponent</strong></td>
<td>All statements, responses and body language were respectful and appropriate.</td>
<td>Most statements, responses and body language were respectful and appropriate.</td>
<td>Some statements, responses and body language were just borderline appropriate and there were some sarcastic remarks.</td>
<td>Most statements, responses and body language were just borderline appropriate and there were a lot of sarcastic remarks.</td>
<td>All statements, responses and body language were inappropriate and sarcastic remarks were prominent the whole time.</td>
</tr>
</tbody>
</table>
Ms Honeylen began the debates with the first two teams. The other teams were given the tasks of taking notes and serving as informal adjudicators, so that they could offer their comments after the rounds. Ms Honeylen herself acted as the chief adjudicator who determined the winner for each round. There were 10 teams in total for Ms Honeylen’s class.

At the end of all the rounds, the class was tasked to make a list of final propositions about the motions discussed as a conclusion.

The class was also asked to reflect on two aspects of the debate activity:

1. The concept of sustainability in line with renewable and non-renewable resources.
2. Their debating skills exhibited during the activity.

During the debate, students were not allowed to access data that helped their arguments, and had to rely on memorised knowledge from their Science class and their own logical reasoning skills to craft their arguments.

**Tip**

To ensure students are consistently observing the debate format, the teacher should also moderate the debate while performing the role of lead adjudicator.

The adjudicators looked out for:

- Validity of arguments
- Debating skills
- Presence of fallacies, if any
- Teamwork dynamic of both teams in arguing for/against the motion
- Attitudes and values shown by each speaker

Aside from taking notes about the content of the debate, Ms Honeylen noted the debating skills shown by the students, as well as the values and end objectives demonstrated from their pitch. These were shared with the rest of the class after every round.

**KEYWORD**

Adjudicator: a person who judges the outcome of the debate

Fallacy: a belief that is built on unsound arguments

At the end of all the rounds, the class was tasked to make a list of final propositions about the motions discussed as a conclusion.

The class was also asked to reflect on two aspects of the debate activity:

1. The concept of sustainability in line with renewable and non-renewable resources.
2. Their debating skills exhibited during the activity.

**KEYWORD**

Proposition: a statement that expresses an opinion
This self-assessment is important as the debate activity is very subject-focused and self-assessment may not emerge automatically. Students need to be given the opportunity to look back on both the content of the debates (i.e., renewable and non-renewable energy) and their performance (i.e., their communicative skills). This will hopefully enable them to reflect not only on how they performed during the debates, but also on what sustainability means in terms of energy, and its impact on the country.

Some guiding questions to prompt reflection are:
1. What specific concepts or new concepts have you learned about renewable and non-renewable energy after the debates?
2. What did you learn about your speaking and debating skills after performing in a debate?
3. Is there anything you need to improve on in terms of speaking and debating skills? What is this and why?

Extending learning beyond the lesson
It is important also to help students see the relevance of the debates beyond them being just a classroom activity. Ms Honeylen believes it is critical to make the learnings real and relevant to the students. She suggests some possible follow-ups to this lesson:

Potential challenges during the implementation of the activity

### Challenge

<table>
<thead>
<tr>
<th>DEBATE FORMAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Debating was not a common activity in the Integrated School, and this was the first time the students did it. Hence, there were many adjustments needed in terms of the mechanics of debating and subscribing to the chosen format (Asian parliamentary).</td>
</tr>
</tbody>
</table>

### Potential solution

This was resolved by showing many examples of debates using the chosen format. Ms Honeylen also addressed questions from the students during the 15-minute preparation time before each round.

### ADJUDICATION

| Since Ms Honeylen was the only expert in the room to adjudicate, there were difficulties in taking note of all aspects of the activity. |

### Potential solution

This was resolved by asking the observers (students not debating) of their comments to help in covering all aspects. Ms Honeylen could then focus more on the skills and affective factors and left the comments about the content to the observers.

### TIME CONSTRAINT

| Time constraint was a big challenge since there were many groups and only one hour per class period. |

### Potential solution

Ms Honeylen scheduled the teams such that some of them debated on other days.
Teacher’s reflections on the lesson

The success of the activity depended on the scaffolding of tasks and training on skills set. I was able to plan half of the term (1.5 months) to structure all lessons and activities so that they culminate smoothly to the debate activity. Because of this, the students did not feel like the activity was out-of-the-blue and actually felt that the debate was the most appropriate final activity. I also asked for the help from the Science teacher to integrate in their lessons the topic for the debate. This is to help students substantiate their arguments.

Since the students had no previous experience in debating, it was very fulfilling to see the light bulb moments of the students during the processing of the activity. Some of them felt like arguing more because they felt strongly about the motions; however, they were limited by the structure of the debate. This was a pivotal moment for me since it was an indicator of learning by the students.

Lastly, I believed that the debate was the best activity to engage students with the topic of sustainability and renewable energy, as it taught students how to apply persuasive language skills — where lessons in English were about fallacies, speeches and argumentation — while deepening their understanding of technical content knowledge for the discussion about sustainability.

- Ms Honeylen Libunao

Try it out!

Now that you have learnt how a debate on sustainability could be carried out, and seen examples of motions on sustainability issues, you can plan a similar debate for your students. What are some possible motions based on sustainability topics related to your local context that you can use?

2.4
Addressing inequality for a more sustainable world
Ms Divine Mercy M. Go, Mr John Brian S. Molina & Mr Domingo S. Adolfo, Jr

When addressing issues of sustainability and sustainable growth, it is not often that one considers history as the place for understanding these topics, or to derive its solutions. Three history teachers Ms Divine Mercy M. Go, Mr Domingo S. Adolfo, Jr, and Mr John Brian S. Molina show how they have crafted a lesson connecting colonial history to global inequality, thus imparting the importance of attaining the UN SDGs for equitable global development. We understand, from their example, how to make use of collaborative learning techniques to facilitate group work and class discussions, and how, reflecting on one’s history and identity as a Southeast Asian, one can feel empowered to take individual action for a more sustainable and equal world. This unit on colonial history was led by Ms Divine Mercy.

Try it out!

Now that you have learnt how to incorporate both History and Geography competencies through map reading and analysis, how to incorporate the importance of the SDGs in a lesson on colonial history, and how to facilitate a collaborative learning activity and class discussion, using digital tools.

In this chapter, we learn:
- How to incorporate both History and Geography competencies through map reading and analysis
- How to incorporate the importance of the SDGs in a lesson on colonial history
- How to facilitate a collaborative learning activity and class discussion, using digital tools
In the Filipino Grade 7 History syllabus, students learn the implications of imperialism on the present way of life of Southeast Asians. Specifically, the occupation and control of Europeans in economic, social, political and other aspects: (1) Indonesia and the Netherlands; (2) Myanmar, Malaysia, and Singapore and Great Britain; (3) the Philippines under the Spaniards; (4) Indochina and France; and (5) How Thailand remained free from western imperialism.

The Philippine geography features diverse land and water forms abundant in natural resources. Despite this, the country and regional Southeast Asia face many challenges to growth and development. Western imperialism had caused a massive impact in the present condition of the region; previously colonised nations were sources of raw material and a field market for surplus product from the western world. Many systems perpetuating inequality persist in the modern day, and the historical circumstances of colonised Southeast Asia has hindered many nations from developing at an equal rate similar to its colonial counterparts.

SDG Goal 10 and Southeast Asian colonial history

Sustainable Development Goal 10 specifically deals with reducing inequality within and among countries. This goal targets reducing income inequality, dismantling structural and systemic discrimination, and ensuring safety of migrants and refugees. Its main aims include:

- By 2030, progressively achieve and sustain income growth of the bottom 40% of the population at a rate higher than the national average.

- Ensure equal opportunity and reduce inequalities of outcome by eliminating discriminatory laws, policies and practices, and promoting appropriate legislation, policies and action in this regard.

- Ensure enhanced representation and voice for developing countries in decision-making in global international economic and financial institutions in order to deliver more effective, credible, accountable and legitimate institutions.

The Philippine geography features diverse land and water forms abundant in natural resources. Despite this, the country and regional Southeast Asia face many challenges to growth and development. Western imperialism had caused a massive impact in the present condition of the region; previously colonised nations were sources of raw material and a field market for surplus product from the western world. Many systems perpetuating inequality persist in the modern day, and the historical circumstances of colonised Southeast Asia has hindered many nations from developing at an equal rate similar to its colonial counterparts.

Equitable global development

Learning about colonial history and its influence on the inequality in Southeast Asia is crucial for students to understand the forces that shape the present, and to discern contemporary social injustices perpetrated by colonial powers. Understanding colonial history allows students to develop critical thinking skills, and inculcate empathy and tolerance for indigenous groups.

The current issues and challenges present in Southeast Asian countries are better understood by its root from the historical processes of colonialism. SDG 10 focuses on addressing inequality between and within countries, and learning about the root cause and contributing factors to persisting inequalities provides meaningful understanding to the aims of the SDG 10. Students can also contextualise what Goal 10 means for them and for the nation, through having knowledge of the historical factors that hinder equitable development.
Understanding colonial history in Southeast Asia

This lesson is suitable for students studying the causes and effects of colonialism in Asian History, and its implications on sustainable development. It can be adapted to suit different levels in junior high school and topics in History (e.g., World History, Contemporary Philippines). Ms Divine Mercy was the lead instructor for this topic.

Desired learning outcomes and lesson objectives

The main topics covered in this lesson are:

- Imperialism and colonialism: Understanding the history and reasons for colonialism, and its impact on countries in Southeast Asia.
- Understanding the UN SDGs and how it relates to addressing contemporary issues rooted in colonialism in Southeast Asia.

Knowledge and Skills

From the lesson, students will be able to gain the following knowledge and skills:

- Students will be able to explain the reasons, methods and important events related to Western imperialism in Southeast Asia.
- Student will be able to analyse the effects and implications of Western imperialism in the lives of Southeast Asians.

Reasons

- Effects of Western imperialism in Asia are still evident in many countries in the region. These countries are years behind due to the past exploitation of their resources and labour, which contributed to the development of the Imperialists.
- The UN designed the SDGs to address pressing global issues, one of which is the inequality and inequity among and within countries as a large portion of the world's wealth is held by few countries/individuals. Equal opportunities and prosperity must be available to every country for them to flourish.
VALUES
Through the lesson, students will cultivate the following values:

<table>
<thead>
<tr>
<th>Values</th>
<th>Reasons</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACTIVE PARTICIPATION</td>
<td>Southeast Asia, where most countries have been subject of Western imperialism, is currently facing the remains and impacts of colonial rule which includes socio-economic inequality. It is significant to acknowledge how historical processes such as imperialism affected the current landscape of many previously colonised countries.</td>
</tr>
</tbody>
</table>

Carrying out the lesson

MAP ANALYSIS
The lesson starts with the teacher presenting students with a world map that shows global inequality based on countries’ total gross domestic product (GDP). This activity helps students identify where developed and developing countries are, and connect this to prior knowledge on historical background of these nations.

This lesson also makes use of inquiry-based learning (IBL) to frame the class. Flip to Chapter 1.2 to read more about IBL and how it's used to structure a curriculum.

The students will be asked to answer the following guide questions, and responding on the Quizizz app:

- Which region/countries are highlighted in dark green?
  - How would you describe these countries in the present?
  - How would you describe these countries based on historical contexts?

- Which region/countries are highlighted in orange and red?
  - How would you describe these countries in the present?
  - How would you describe these countries based on historical contexts?

- What do you think is the concept implied in the image/map?

The activity makes use of the application Quizizz.
By using the coloured map to show global distribution of GDP and connecting it to prior knowledge, students are led to enquire why global distribution of GDP is unequal.

**Tip**

Using materials such as maps allow students to acquire concepts more effectively and stimulate critical and creative thinking. They are prompted to connect visual information with prior knowledge.

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**COLLABORATIVE LEARNING AND GROUPWORK USING GOOGLE JAMBOARD**

The class is then divided into four groups to work on different tasks on a Jamboard activity sheet. In this activity, students gather information on which countries were colonised, and why.

Each group is assigned a Google Jamboard page with 10 minutes to finish the task assigned. Teachers act as the main facilitator, and address any questions or misconceptions during the activity.

After completing the activity, the teacher calls on a representative from each group to present their work to the class.

**Google Jamboard** is a digital whiteboard that allows collaborative work with a Jamboard device, web browser or mobile app. It can be used with the G Suite of applications (e.g., Drive, Docs and Sheets) and can also be used to host video meetings.

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**RECALL**

how to make use of Jamboard in our handbook, *Enhancing Remote Learning*
The groups and activities are:

**GROUP 1 Mapping**
In the blank map of Southeast Asia, colour the parts that correspond to the territories that the given imperial powers controlled during the period of imperialism. Name each country/territory occupied and put the flag of the imperial powers to their designated territories based on the colours you put in the map.

**GROUP 2 Collage**
Give the causes/reasons and effects of Western imperialism in Southeast Asia using four pictures in a collage. Put a one-word label/caption to each picture.

**GROUP 3 The Gist**
Create a three-point timeline of the important events during the Spanish colonisation of the Philippines. Summarise the events and write the important points in bullet-point or short-sentence answers only.

**GROUP 4 At the Moment**
Draw an image showing the effects/impact of Western imperialism in Southeast Asia today. Write a one-sentence caption to explain its meaning.
1. Deepening understanding of concepts
Students are introduced to the concepts and events surrounding colonialism in Southeast Asia through the different activities. The group work forms the basis for class discussion, and later evaluation of the different concepts.

The discussions that arise from completing the activity helps students integrate core ideas of the topic of Asian history, such as the importance of spices, natural resources and key trade routes to historical colonial powers.

Tip
Dividing the class into groups that cover different topics helps the class cover large topics quickly, while aiding the teacher in facilitating the teaching-learning process. It is easier for students to discover knowledge on their own through facilitation and use of graphic organisers, as opposed to listening to a lecture and getting overloaded with information. Grouping students according to topics and using graphic organisers also allow teachers to break down and simplify concepts, while highlighting key words.

2. Developing collaborative and critical thinking skills
Collaborative learning is a key aspect of 21st century education, where students are given the space to actively discuss, debate and clarify topics and ideas with their classmates through group work and facilitated discussion. Classrooms with well-organised collaborative work created a healthy learning environment for students to gain social and academic skills.

3. Incorporating appropriate technological tools
A great way to facilitate collaborative learning and group work is to use the appropriate online tool. Applications such as Jamboard and Quizizz can create unique interactions between students while helping them engage with subject content, maximising their learning experience.

RECALL
how to design the appropriate online learning experience for your class with three guiding questions from our handbook, Bridging the Gaps in Remote Learning

Examples of students’ responses to the activity in Ms Divine Mercy’s class
FACILITATED DISCUSSION

The teacher will then process the activity and facilitate a discussion on the important concepts related to the topic. Responses from the students will also be gathered through critical processing questions that will be posted from time to time during the activity.

During facilitated discussion, the teacher engages students and uses their own responses to enquire more deeply into the connection between the question posed to them during map analysis, and the information gathered during group work.

Examples of processing questions used in this lesson are:

• How did the geographical factors contribute to the interest of the imperial powers in occupying Southeast Asia?

• What political, economic and socio-cultural benefits will the imperial powers gain in occupying the territories in Southeast Asia?

• How did the establishment of private companies such as the British East India Company and Dutch East India Company strengthen the imperial rule in Southeast Asia?

• How did the British use Burma (present-day Myanmar) in aiding their colonial rule in India?

• How did the religion of Christianity play an important role in the Spanish colonial rule in the Philippines?

• How did imperialism change and influence the present Asian society?

• What present-day issue/situation can be considered as a persisting impact of imperialism in Southeast Asia?

Ms Divine Mercy, Mr Domingo and Mr John believe in the importance of designing good processing questions, because such questions can promote deeper student learning by:

• Being of a high-order nature and facilitating thinking at the highest cognitive level, i.e., the answers to these questions should not be easily obtainable just by reading a text or by recalling facts

• Being thought-provoking, i.e., they require students to think deeper and more critically

• Encouraging students to clarify their understanding and support their interpretations with relevant evidence

In the discussion, it is critical to consolidate the big ideas underpinning this activity. The ideas covered in this lesson are:

• Identifying the objectives and methods of the imperial powers in occupying countries in Southeast Asia

• An explanation of the effects of imperialism on countries in Southeast Asia

• Western imperialism has continuing effects on countries in our region, which affects families suffering from poverty, malnutrition and other societal problems
THE ROLE OF THE SDGS IN DISMANTLING GLOBAL INEQUALITY

To conclude the lesson, the statement below can be shown to invoke students’ reflections:

“The immense economic inequality we observe in the world today is the path-dependent outcome of a multitude of historical processes, one of the most important of which has been European colonialism.”

Acemoglu and Robinson, The Economic Impact of Colonialism (2017)

The immense economic inequality we observe in the world today is the path-dependent outcome of a multitude of historical processes, one of the most important of which has been European colonialism.”

Acemoglu and Robinson, The Economic Impact of Colonialism (2017)

The teacher will then briefly introduce the appropriate SDG Spotlight for the topic and show a short UN SDG video.

Tip
The use of reflective questions cultivates students’ awareness of what they are learning and inculcates application of these concepts to real-life experiences.

To cultivate the students’ awareness of what they have learnt and to encourage the application of these concepts learnt to real-life experiences, the teacher asks the following questions:

- As an Asian, how do you think this issue affects your daily life?
- How can you contribute in your own way in achieving SGD#10 Reduce Inequality Within and Among Countries?

The Sustainable Development Goals (SGDs) aim to address the global challenges we face, one among the pressing concerns is the inequality among and within countries. Most of the world’s wealth is held by a small percentage of individuals. For nations to flourish, equality and prosperity must be available to everyone. When every individual is self-sufficient, the entire world prospers.
**Challenges and solutions in lesson implementation**

**Challenge**

**AVAILABILITY OF LEARNING DEVICES**

The activity requires the use of a learning device (iPad, laptop) for the students to research information and participate in the activity. This might be a challenge when not all students have a learning device.

**Potential solution**

The teacher may guide the students to share devices with their group mates and designate alternative tasks (e.g., presenter) in order for everyone to participate.

**TIME CONSTRAINTS**

Activities might be time consuming if not implemented in an organised way.

**Potential solution**

There must be clear guidelines set by the teachers such as the time taken to accomplish the task, designating places inside the classroom where students perform the activity, and consistent check-ins on students’ progress.

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**Student voice**

"As an Asian, the inequality within and among countries is very evident today. Countries that were imperialists before have better economies, infrastructure, and much more. As for many countries here in Asia, there are many poor people and unfortunate families all around, our economy here in the Philippines isn't going as well and many countries in Asia are still developing countries. As a 7th grader, I can contribute to helping by spreading awareness of the inequality within and among countries, and though it isn't much, if we persist, one day we will finally achieve our goal.”

In my own ways, I can contribute to achieving the SDGs simply by spreading awareness and encouraging elders to vote for political candidates wisely. Since citizens do not have ample power to make a big change in these types of issues in society, we should root for those who have the ability of prioritising and taking action to make wise economic decisions. We should also keep in mind that small acts of kindness make a big change. Donating to charity-related programmes, campaigning, and protesting are incredibly beneficial for those who are enduring the aftermath of this issue.”

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**SDG Spotlight and reflection questions**

The questions are posted on Canvas (a digital learning management system) where students are to submit their responses.
What is the right age to teach young learners about sustainability? Social Science teacher Ms Judy Sullano believes that sustainability education can and should start at a young age. She demonstrates this with a two-week lesson on the impact of economic activities on the environment, and connecting individual action to larger societal change for a sustainable society. With lessons moving online during the pandemic, Ms Judy also demonstrates how she makes use of technology-enabled blended learning to facilitate a flipped classroom experience.

### 2.5 Understanding the impact of economic activities through a flipped classroom experience

Ms Judy Sullano

In this chapter, we learn:
- How the Sustainable Development Goals are relevant to national development goals
- How different economic activities carried out in the Philippines have an impact on the environment
- How to use technology to enable a flipped classroom experience

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**Teachers’ reflections on the lesson**

Students can enjoy the teaching-learning process if given a chance to participate and present in front of the whole class. Processing their ideas is very crucial; therefore, the teacher must lead them to accomplish the objectives and desired learning competencies. As early junior high school students, most of them are already aware of the current issues in Southeast Asian countries and from there, the teacher’s role is to highlight its relation to the topic discussed. Expanding the students’ critical thinking by asking relevant questions about the topic helps the teachers evaluate the root cause and effects of imperialism.

When asked to think of a way to promote equality and prosperity in every country, some of the students may have limited ideas on how they can be of help. This is where the teacher introduces the role of the UN SDGs in addressing inequality among countries.

- Ms Divine Mercy M. Go, Mr Domingo S. Adolfo, Jr & Mr John Brian S. Molina

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**INSTITUTIONAL PROFILE**

De La Salle University Integrated School

**LOCATION**
Biñan, Laguna, the Philippines

**TYPE OF INSTITUTION**
Private grade school

**GRADE LEVEL**
Grade 4 (ages 9 –11)

**NUMBER OF STUDENTS**
22–27 per class

**SUBJECT/DISCIPLINE**
Social Sciences
### Blended learning using a flipped classroom model

Ms. Judy structured her class around the flipped classroom model. A flipped classroom is structured around the idea that lecture or direct instruction is not the best use of class time. Instead, students encounter information before class, freeing class time for activities that involve higher-order thinking.

She first engaged students with a pre-lesson activity that helped them pick up key information about the SDGs and sustainable development, before moving into a synchronous class activity that allowed them to apply that knowledge using tools such as Pear Deck and Nearpod. This gave her time to build in collaborative activities during class time, and stimulate students with a final application project.

The two-week unit culminated in a video blog (vlog) assignment, where students related the nation’s broader development goals and sustainability efforts with events and activities in their local community, pointing out things they could do as individuals for a more sustainable society.

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### SDGs, national goals and individual action

It is important to introduce students to not just the UN Sustainable Development Goals (SDGs), but relate them to national development and sustainability goals as well. Students from as young as nine years of age can relate these goals to the economic and environmental activities happening in their country and local community, and make the connection with how individual action can contribute to sustainability goals as a whole.

**Food for thought**

- What are some of the national development goals in your country?
- What are some national goals related to sustainability and environmental protection?
- Are there contradictions or tension between these goals?
- What do you think sustainable development looks like for your country?

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**Sustainable development has been defined by the UN as:**

Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.
Applying this in line with Bloom’s taxonomy, we see how students can accomplish lower levels of cognitive work before class, allowing the teacher to engage students in higher cognitive levels of learning together with peers.

**Lesson Plan**

**Tackling the impact of economic activities on the environment**

Ms Judy’s lesson took place over two weeks, utilising both asynchronous and synchronous methods. The first week covered the bulk of the content while the lesson in the second week served as a review and follow-up for the first. As a result, there is much building upon what had been previously taught and learnt, which can help reinforce knowledge and effect a change in behaviour.

The main topics covered in this lesson are:

- Understanding the definition of sustainable development and the different SDGs
- Challenges to sustainable development presented by different national economic activities
- Opportunities for advancing the SDGs and national sustainable development through different government-initiated programmes and services

Revised Edition (By Lorin Anderson)
Desired learning outcomes and lesson objectives

**KNOWLEDGE AND SKILLS**

From the lesson, students will be able to gain the following knowledge and skills:

<table>
<thead>
<tr>
<th>Knowledge and Skills</th>
<th>Reasons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students will be able to define the meaning of sustainable development.</td>
<td>If students can define sustainable development using their own words, it will help them get a deeper understanding of the lesson.</td>
</tr>
<tr>
<td>Students will be able to explain the importance of the UN SDGs.</td>
<td>By understanding how the UN SDGs are important and beneficial to everyone, students can develop insights into critical issues that are happening not only in the country but all over the world.</td>
</tr>
<tr>
<td>Students will be able to name the economic activities in the Philippines.</td>
<td>Learning about the different economic activities will help students learn and appreciate how products and services are being produced in the country.</td>
</tr>
<tr>
<td>Students will be able to discuss the challenges and opportunities of the different economic activities in the country.</td>
<td>Engaging in discussion can help develop the skills needed to process information based on the given facts.</td>
</tr>
</tbody>
</table>

**VALUES**

Through the lesson, students will cultivate the following values:

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>PROACTIVE PARTICIPATION</strong> Students will be able to participate in activities that promote the sustainable development of our natural resources.</td>
<td>The government and the citizens work together to promote sustainable development. As the future of the country, it is important for students to play a vital role in taking good care of the environment, even in simple ways.</td>
</tr>
</tbody>
</table>
Carrying out the two-week unit

1. PRE-LESSON ASYNCHRONOUS ACTIVITY

In the first week, Ms Judy started the lesson with an asynchronous activity, by getting her students to watch the following videos on the UN SDGs.

The videos gave students the background knowledge needed to link ideas of sustainable development and the SDGs with the environmental issues faced by the country.

2. LEAD-IN ACTIVITY

For the actual lesson, Ms Judy’s lead-in activity involved the use of Pear Deck, an online learning application. On Pear Deck, pictures showing different economic activities in the Philippines, such as fishing, farming, mining, business and commerce, were displayed. Students were tasked to decide if the economic activity shown was good for the environment.

If an economic activity was deemed good for the environment, they had to drag an icon (a light green circle) to a thumbs-up sign.

Students are able to master lower-order skills such as recalling facts and understanding concepts (as reflected in Bloom’s taxonomy) during the pre-lesson activity, so that class time can be dedicated to higher-order skills, such as application of content, analysing and evaluating concepts, and creating something from what they have learnt.

The asynchronous activity built on the previous lesson where the class examined the different environmental issues in the Philippines that impact the country’s growth and development.

Activating prior knowledge

Directions: Drag the icon 🟢 if the picture shown is GOOD for the environment and to 🟢 if it is NOT.

Instructions on Pear Deck for the activity
Activating prior knowledge

The lead-in activity built on Ms Judy’s previous lesson, where students discussed these different economic activities. In that lesson, the students learnt that there are many challenges facing the country due to the negligence and abuse of the country’s natural resources. As a result, the government has created opportunities and programmes that people can participate in to solve these challenges to promote sustainable development and further enrich the country’s economic activities.

Conversely, they had to drag the same icon to a thumbs-down sign if they considered the economic activity to be harmful to the environment:

In this activity, students apply what they have learnt from the pre-lesson assignment, and demonstrate to the teacher how well they understood the information.

Tip

Introducing applications like Pear Deck into your classes makes lessons more engaging for young learners. Integrating activities that help check on students’ prior knowledge makes the class smoother.

3. LEADING THE CLASS IN A COLLABORATIVE LEARNING ACTIVITY

Moving into the main part of the lesson, Ms Judy began by asking her students to define the following concepts and words:

- Sustainable development
- Sustainable development goals
- Challenges
- Opportunities

Collectively defining these terms allows students to build their vocabulary and align on the basic terminology used in the lesson, so they can better express their ideas.

The class was then divided into five groups, with an economic activity assigned:

- Group 1: Farming
- Group 2: Fishing
- Group 3: Forest-related activities
- Group 4: Mining
- Group 5: Business and commerce
The groups were tasked to identify the opportunities and challenges faced by the economic activity assigned to them, and to present their findings using Google Slides. They were given 15 minutes to work collaboratively in Zoom breakout rooms.

This activity allowed the students to develop soft skills such as communication, time management and teamwork. It was also interesting for Ms Judy to understand, from their responses, what students considered were challenges to sustainable development, and the possible solutions they found.

After the different groups had presented their work, Ms Judy wrapped up the lesson by asking them the following questions:

1. What are the challenges faced by the country’s economic activities?
2. What actions does the government take to address the different economic challenges?
3. How can people help in solving the challenges of pursuing economic activities while prioritising sustainable development?

These questions helped Ms Judy to check her students’ understanding of the lesson, and encouraged the class to think about their part to play in the solution as Social Science students.

As a recap, Ms Judy started the lesson by getting her students to correctly match the correct economic opportunity to their corresponding challenges on Nearpod.

Nearpod is an online educational learning application suitable for K-12 students and teachers. It allows the creation of interactive lessons, videos, gamification and activities, and comes in free and paid versions.

SCAN TO LEARN more about Nearpod

Nearpod activity requiring students to match the economic opportunity to the challenge involved
To synthesise their knowledge from the previous activities, students were posed two discussion questions:

1. What do you think will happen if people continue to destroy our environment?
2. As a Lasallian, what can you do to take good care of our natural resources?

**Tip**

Reviewing helps students to strengthen what has been learnt previously. It also allows teachers to reflect and assess the efficacy of their instructional strategies.

**Vlog project guidelines**

1. Identify five activities that show how they take good care of their environment.
2. Use the correct tenses of verbs in making their vlog.
3. Write a script that includes an engaging introduction, greeting, topic, the actions the student would take to care for the environment, and a message to inspire the audience to do the same for the environment.

**EVALUATION AND CREATION**

Having learnt the different challenges and opportunities in the different economic sectors of the country, students had a chance to learn how to apply their knowledge and take individual action to positively impact the environment. Thus, a final vlog project was conceived as a collaboration between Ms Judy and their English teacher, Ms Cristine.

This is the final post-lesson activity that students can accomplish on their own, evaluating what they have learnt and creating something from the gained knowledge.

In this project, students were tasked to individually create a vlog of about 2 to 4 minutes, explaining five individual actions they could take to contribute towards the national attainment of the SDGs.

The students had the following guidelines to work with:

Vlogs by Ms Judy’s students, demonstrating how they would care for the environment.
The lesson ended with a reflection question for students to find the connection between what they had learnt and their personal experience, which Ms Judy hoped would challenge them to take practical steps to protect the environment:

Why do we need to take good care of our environment?

Students submitted their responses in a reflective journal, responding to these four prompts:

1. Did you enjoy our lessons? Name an activity that you enjoyed the most.
2. Do you have any suggested activities in mind that you want to have for term 3?
3. Do you have a favorite topic? What is it about? Why do you like it the most?
4. Lastly, what are the things that you have learned in this term? As a Lasallian student, how will you apply these things in real life?

Congratulations, you are now in the final activity for term 2. In this term, we learned about Philippine society, culture, and economy. We also realized the importance of participating in the activities that develop and promote the sustainable development of the country’s natural resources. Before your term break begins, I want you to answer these questions in a paragraph form:

I enjoyed all our lessons for the 2nd term which are about the Different Economic Activities, Managing the Country’s Natural Resources, Growth and Development of Our Country and lastly The Filipino Culture and Identity. I also learned about the Sustainable Development Goals and some facts about the United Nations. Doing our PTs are also fun for me and challenging because I need to be creative and our discussion every Thursday is fun too. Being a Lasallian I need to do my part in taking care of the environment and natural resources like conserving water, energy and avoiding causes of pollution because its one of the important things I learned in our lessons.

Canceran, Louis Lorenzo B

I enjoyed our lessons, and the activity that I liked the most was when we had to drag or type the word to complete the sentences which was in almost all the lessons. I would love to have the same activities for term 3 like in term 2 because they were so much fun. I would also like to share that my favorite topic was Managing the Country’s Resources and the Growth and Development of Our Country. It was about dealing with challenges of using the natural resources and the solutions. I was fascinated to learn that taking care of these resources through sustainable development programmes can benefit future generations. Lastly, in this term, I have learned about the economic activities like mining, fishing, farming, and many others in the Philippines and how I, as a Lasallian, can contribute in taking care of the natural resources in our country. I will apply these things in real life by committing to and supporting the sustainable development programs in simple ways that I can like conserving water and energy, segregating waste, and buying local products and services.

Mendoza, Zachary Aaron
Challenges and solutions in lesson implementation

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Potential solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIGRESSION FROM TOPIC</td>
<td>Ms Judy checked in on all breakout rooms and facilitated the discussions to keep students on track.</td>
</tr>
<tr>
<td>TIME CONSTRAINTS</td>
<td>For groups that needed more time to complete their tasks, Ms Judy allowed them to present their work in a subsequent lesson.</td>
</tr>
</tbody>
</table>

Teacher’s reflection on the lesson

The year 2030 is just around the corner, and there are still a lot of things that must be done to achieve the sustainable development goals. Everyone is called to be part of this agenda, as the consequences will significantly impact the present and future generations.

Teaching sustainable development goals is one way to achieve and promote a sustainable future. Teaching this requires a creative and engaging approach that encourages hands-on learning, practical application, and collaboration aligned with the learners’ needs and abilities. Ultimately, I hope this lesson empowered my students to make a difference by being responsible and active citizens committed to promoting sustainability.

- Ms Judy Sullano
Indigenous knowledge and alternative energy sources

Indigenous knowledge refers to the wisdom and practices of indigenous communities based on cultural traditions, beliefs and experiences passed down through generations. This knowledge is often deeply connected to how people interact with the local environment, and includes knowledge about ecosystems, plant and animal species, weather patterns, and natural resources.

Indigenous knowledge encompasses a wide range of topics, from traditional medicine and healing practices, agriculture and food systems, to spirituality and cultural practices. It is often transmitted through oral traditions, story-telling and experiential learning, and is deeply tied to the cultural identity and sense of place of indigenous communities.

Indonesia is home to many indigenous knowledge systems that have long emphasised sustainable living and the harmonious relationship humans have with the environment. Indigenous communities in Indonesia have developed various methods to reduce energy consumption and promote sustainability, such as:

Moving away from fossil fuel consumption is a key step in combating climate change and pollution. In recent decades, many renewable energy technologies such as solar power and hydropower have been invented to serve as sustainable alternative energy sources, with many countries increasingly investing in renewable energy. What may be lost in contemporary conversations on energy however, are the techniques used by societies to perform core functions like cooling and lighting, before electricity was invented.

In this chapter, Dr Stien and Ms Ayuk walk us through modern alternative energy inventions, indigenous Balinese knowledge of biofuel production for lighting lamps, and energy-conserving architecture used in traditional Balinese houses, as ways to reduce reliance on fossil fuels.
Indigenous communities in Indonesia have traditionally utilised passive cooling techniques in their homes. These include strategic building orientation to maximise natural ventilation, designing houses with elevated floors to allow air circulation underneath, and incorporating large windows and open spaces to promote airflow and reduce the need of artificial cooling.

Traditional Balinese home architecture accommodates the warm and humid climate through incorporating large windows and open spaces, a ventilated double roof, and using natural materials with low heat storage capacity.

Balinese traditions are unique from other Indonesian ethnic traditions, having evolved on the island of Bali. Most Balinese people practise Hinduism, unlike the majority of Indonesians who practise Islam. Even within the island of Bali, there are more than nine ethnic groups living harmoniously together.

Did you know

Indonesia is extremely ethnically diverse, with more than 1,300 ethnic groups! Each community boasts long traditions of their own. The current distribution of ethnic groups in Indonesia is as follows:

- Javanese 40.1%
- Sundanese 15.5%
- Malay 3.7%
- Batak 3.6%
- Madurese 3.0%
- Betawi 2.9%
- Balinese 1.7%
- Other 29.5%

Apart from being constructed above street level to allow for natural ventilation and a good vantage point, traditional Nias houses of Omo Sebua and Omo Hada are also built entirely without nails, and are made to withstand earthquakes.
B. SUSTAINABLE AGRICULTURE AND WATER MANAGEMENT

Indigenous communities practise sustainable farming techniques that reduce energy consumption. This includes utilising organic farming methods, crop rotation, and intercropping to improve soil fertility and reduce the need for chemical inputs.

The subak system of agriculture in Bali is a democratic and egalitarian farming system centred around communal and sustainable water management. This farming philosophy is manifested in a network of 1,200 water collectives, which regulate and sustain rice terraces all over Bali. Water temples become centres of cooperative management by a group of subaks. This collective and integrated water system supports rice fields without the need for machine interventions, allowing Bali to produce enough rice to feed a dense population, and connects communities together.

This is an example of the Balinese philosophy of Tri Hita Karana — the seamless connection of spirit, nature, and the human world, through integrated farming and water management.

Pura Ulun Danu Beratan is the temple of Lake Bratan that serves the entire region in the outflow area.

C. BIOFUEL AS AN ALTERNATIVE ENERGY RESOURCE

Communities in Bali make use of biofuel as alternative energy sources to electricity. The use of biofuels such as arak and castor oil is prevalent in Balinese traditional practices and ceremonies.

Castor oil is used for lighting templok lamps (traditional kerosene lamps), and as torch fuel for traditional ngaben (funeral) ceremonies and birth celebrations in Bali.

Arak, an oil produced from coconut trees, is also used as a biofuel for lighting lamps in ceremonies, and distilled into alcohol as another form of alternative fuel.

A farmer from Karangasem is heating up the furnace with wood and bamboo to produce arak.

Image source: NOW! Bali Magazine
In recent years, there has been growing recognition of the value and importance of indigenous knowledge, particularly in the context of sustainable development, environmental conservation, and climate change adaptations. One of them is indigenous knowledge and use of alternative energy sources, such as biofuel.

By incorporating indigenous knowledge and practices into modern energy-saving technology and practices, we revive ancient wisdom and reduce our reliance on fossil fuels, leading to a more sustainable future for all.

**Did you know**

Alternative energy refers to any form of energy produced from renewable and sustainable sources, rather than from non-renewable sources such as fossil fuels-derived coal, oil and natural gas.

In the following lesson plan, Dr Stien and Ms Ayuk share how students in SMA Negeri Bali Mandara learn about traditional Balinese methods to reduce fossil fuel consumption, and how they make use of these principles in their daily lives.
Indigenous knowledge to reduce fossil fuel consumption

Conducted over three sessions, this lesson plan demonstrates collaborative learning strategies and interactive learning activities to help students identify indigenous methods for reducing fossil fuel consumption and using alternative energy sources. Originally a lesson teaching students about renewable energy, Dr Stien and Ms Ayuk adapted their lesson to teach students about the unique Balinese practices that can reduce reliance on fossil fuels.

Students reinforce their knowledge through an application activity, where they distil their own castor oil, and craft a traditional Balinese house model out of sticks.

The main topics covered in this lesson are:

- Using castor oil as biofuel
- Energy-conserving architecture in traditional Balinese houses
- Main sources of renewable energy

Desired learning outcomes and lesson objectives

**KNOWLEDGE AND SKILLS**

At the end of the lesson, students will be able to:

<table>
<thead>
<tr>
<th>Knowledge and Skills</th>
<th>Reasons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Describe the key beliefs, values and practices associated with preserving the environment.</td>
<td>• Indigenous knowledge has a strong vision for sustainability and can be valuable agents in building students’ awareness on a sustainable future.</td>
</tr>
<tr>
<td>Describe how castor oil is made and used as a biofuel and alternative energy source.</td>
<td>• Many indigenous communities have developed activities that preserve the ecosystem and promote sustainability. Additionally, indigenous knowledge can inform and inspire innovative solutions to environmental challenges, such as saving electrical energy.</td>
</tr>
<tr>
<td>Describe how traditional Balinese architecture promotes natural cooling methods to reduce electricity consumption.</td>
<td>• Exploring the relationship between indigenous knowledge and sustainable practices can be valuable agents in building students’ awareness of a sustainable future. This will be followed by critical reflections on their personal lifestyles.</td>
</tr>
</tbody>
</table>
VALUES
Through the lesson, students will cultivate the following values:

<table>
<thead>
<tr>
<th>Values</th>
<th>Reasons</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHAMPIONING LOCAL TRADITIONS AND KNOWLEDGE</td>
<td>• Recognising and valuing indigenous knowledge is an important step toward creating a more sustainable future.</td>
</tr>
<tr>
<td>PROACTIVELY IMPLEMENT SOLUTIONS</td>
<td>• The younger generations need to learn about the essence of their local wisdom, and adapt it in their own lives.</td>
</tr>
<tr>
<td></td>
<td>• Learning about indigenous knowledge can help young generations to develop a deeper understanding of the world around them, promote cultural diversity and sustainable development that are valuable in many areas of life.</td>
</tr>
</tbody>
</table>

Carrying out the lesson

UNDERSTANDING ALTERNATIVE ENERGY
Students are introduced to the concept of alternative energy sources through researching on common renewable energy resources. To tackle such a large topic, Ms Ayuk used the jigsaw learning method to cover several topics while engaging students’ interest.

KEYWORDS
The jigsaw learning technique: This is a cooperative learning strategy that involves dividing the class into small groups and assigning each group a different topic to understand. After learning about the topic, students are re-grouped so that each group has a representative knowledgeable about one topic. These students then share their knowledge with each other and present their topic to the class.

This technique will help students develop their expertise in a particular area and share that knowledge with their peers, leading to a more comprehensive understanding of the topic.

Flip to Chapters 2.4 and 3.3 to see how the jigsaw technique is used in other lessons!

The class is divided into four groups of five students each. Each group is tasked with one topic to study, and will hence become the “expert” group for that topic. The teacher provides resources for students to start off with. The four topics to be studied are:

**HYDROPOWER**
- ARTICLES: How hydropower works
- VIDEO RESOURCES:
  - The future of hydropower
  - What is hydropower

**WIND ENERGY**
- ARTICLES: What is wind energy
- VIDEO RESOURCES:
  - What is a “wind drought” and its implications
After sufficient time has been given to the expert groups to do their research, the students are regrouped, this time with each new group having at least one member from each of the expert groups. In their new groups, each student presents the expert group findings on their assigned aspect of the topic.

The students are encouraged to ask questions and engage in discussion about each other’s findings. The new groups are then given time to synthesise the information from all the presentations and come to a deeper understanding of the larger topic by making a mind map of the information. Each group then presents its mind map to the class and sticks it on the wall for the class’s reference.

**INTRODUCTION TO INDIGENOUS PRACTICES**

**UNDERSTANDING INDIGENOUS ENERGY-SAVING PRACTICES & ENERGY USE**

After getting a broad picture of what alternative energy is and modern solutions to reduce fossil fuel use, students hone in on Balinese traditions that reduce fossil fuel consumption.

In this lesson, students understand more about Nyepi Day, an indigenous holiday in Bali, Indonesia, and alternative energy sources based on Balinese indigenous knowledge.

The teacher starts the lesson with three mini activities that can help her identify students’ prior knowledge, and help the students to link the topic of the lesson with the indigenous knowledge and the daily activities of the community:

**a. Learning about Nyepi Day**

Students learn about the celebration of Nyepi Day (or “Silent Day”), a sacred Hindu holiday in Bali, Indonesia. They do this through examining photographs and watching video documentaries on Nyepi Day. Students are asked to keep in mind the following questions:

1. Do you remember about what we do on Nyepi Day?
2. Can you describe the situation in the streets and at home? What did you feel?

**Nyepi Day** is a Hindu holiday that is celebrated annually in Bali. It is also known as the day of silence as it is a day of complete silence and self-reflection. All activities are suspended, including work, travel, entertainment and even lighting fires or using electricity. People are not allowed to leave their homes or make noise. People use their time to contemplate their actions and thoughts from the previous year and prepare a new beginning. It is also an example of how Tri Hita Kirana is showcased.
b. Brainstorming the benefits of Nyepi Day for energy conservation

Students engage in the think-pair-share learning strategy for the next activity:

THINK
Students think about the benefits of having a “silent day” for the environment and energy saving.

PAIR
Students are then paired up, or placed in small groups.

SHARE
Students share their ideas in their pairs/groups.

Students’ responses:

“People stay at home so they don’t waste the fuel for transportation, and reduce air and sound pollution from vehicles.”

“People don’t turn on lights at night, so we can save electrical energy.”

“There is no internet connection and no TV broadcast, so we can save electrical energy.”

Question: What are the benefits of having “silent day” for the environment and energy saving?

Question: What is the main source of energy we often use in daily life?

“Electrical energy generated from fossil fuels such as crude oil, coal, petroleum and natural gas.”

After discussing their findings about Nyepi Day, they go on to discuss the following questions on energy consumption using the same strategy:
In this lesson, students are introduced to two indigenous Balinese practices that reduce the use of fossil fuels, and go through the following resources:

**a. USING BIOFUEL SUCH AS CASTOR OIL AS AN ALTERNATIVE ENERGY SOURCE**

- What is biofuel
- How to make castor oil at home

**b. TRADITIONAL BALINESE ARCHITECTURE THAT INCORPORATES NATURAL COOLING SYSTEMS**

- How a Balinese traditional home creates a comfortable internal environment without resorting to energy usage
- Traditional house arrangements in Bali

**c. Consolidation of student knowledge with the KWL organiser**

The teacher then gets the students to pen down their ideas relating to using alternative energy resources in saving electrical energy, using a KWL organiser.

A KWL organiser is a tool that helps students to track and synthesise what they Know, Want to know, and has Learned about a certain topic. For this activity, the students write their ideas under “K” and “W” on sticky notes in different colours.

An example of a simple KWL organiser:

<table>
<thead>
<tr>
<th>Topic</th>
<th>Know</th>
<th>Want to Know</th>
<th>Learned</th>
</tr>
</thead>
</table>

**Question:** How do we use energy in daily life? Is our use of it efficient?

**Question:** How can we use energy more wisely?

**“Common uses of energy such as on a motorbike. Sometimes we forgot to shut off our electrical equipments.”**

**Save energy through using less, find alternative energy sources to fossil fuels.”**
The students then get into Think-Pair-Share groups to share what they have learnt about how both methods reduce the use of fossil fuel consumption. They are also asked to share what indigenous practices from their own community may reduce fossil fuel consumption.

**Hands-on activity to consolidate learning**

To let students get a deeper understanding of how these two methods can reduce fossil fuel consumption, the teacher leads the class in a hands-on activity. The students are split into two large groups. Using the resources they have previously read as a guide, the two groups will each experience an activity.

**GROUP 1**

**Making their own castor oil and using it to light an oil lamp**

Students are supplied:
- Castor seeds
- Mortar and pestle
- A strainer
- Water
- A pot and access to a stove
- A freezer
- A spoon
- Storage bottle for the castor oil

They are guided to follow the steps as laid out in the resources provided to make their own castor oil from castor seeds, for use as lamp fuel.
Constructing their own traditional Balinese house using ice-cream sticks, according to the architectural principles

Students are supplied:
- Ice-cream sticks
- Wooden pieces
- Glue
- Scissors
- Penknife

They are guided to construct their own traditional Balinese house, demonstrating how it incorporates natural cooling systems through its architecture, and following the given resources.

A student group presentation explaining the significance of Balinese architecture; the Bale Dangin Sakepat structure uses natural sources of energy such as wind energy and solar energy to keep the building cool without a fan, eliminating the need for electrical energy use.

A group presentation explaining how the students created their traditional Balinese house structure using sticks and glue, applying Balinese traditional architecture principles.

A student group presenting their traditional Balinese house model to an instructor.
After the activity, students answer a quiz on energy use and alternative energy sources, created using Wordwall.

An image of the quiz on Wordwall, in the form of a game. In this game, students help the astronaut in the middle of the maze to navigate to the correct answer.

KEYWORD

**Wordwall:** An online educational learning application suitable for K-12 students and teachers that introduces gamification elements. It is useful for creating fun, interactive games and classroom activities, which can be printable as well.

On their KWL organiser, the students write what they have Learnt (L) on a sticky note.

They then discuss as a class what they have learnt and how the jigsaw technique helped them in the learning process.

To close off the lesson, students are given a summative test for teachers to evaluate their learning outcomes.

Challenges and solutions in lesson implementation

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Potential solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applying the jigsaw learning technique takes a long time.</td>
<td>Teachers need to provide constant time checks and also to remind students to focus on core learning objectives.</td>
</tr>
<tr>
<td>Students who do not come from Bali and students whose families do not know the customs of the local area will have difficulty finding indigenous knowledge.</td>
<td>Teachers can ask students to speak with their community leaders, traditional village or local residents to connect with their ethnic traditions.</td>
</tr>
</tbody>
</table>
Taking action is an important part of an effective ESD lesson. Providing students with opportunities to act in support of sustainable development issues helps them gain procedural knowledge and skills to go beyond theoretical knowledge. Additionally, because taking action requires knowledge of the context, students have to engage with their physical environment and communities. Not only does this have the potential to build relevant place-based knowledge, it also helps foster a sense of responsibility and attachment towards local spaces and communities. When people care and are empowered with the tools to act, they can become motivated to advocate for sustainable development in the future.

The chapters in this final section share two key features. First, they all involve students learning content and skills with a view towards supporting sustainable development or addressing a sustainable development issue. Second, students are steered into applying knowledge to act in their local contexts.

For example, in Chapter 3.1, Ms Amanda Rachael De Souza and Dr Chen Liu Qi encourage students to design self-watering planters in support of Singapore’s food security goals. The authors of Chapter 3.3, Ms Suwaida Lahama, Ms Mareeyoh Saemahsae, Ms Isara Narawong, Ms Rosakimi Hayee-arong and Ms Aswanee Mathawee, make it a point to ensure students do not just learn about wave properties and coastal erosion, but also apply their knowledge to design solutions to coastal erosion along the east coast of Narathiwat province where their school is located. Their lesson is carefully scaffolded with opportunities for students to engage with nearby communities who are impacted by rising sea levels. In Chapter 3.4, Hj Muhamad Zuwaini Hj Aliyani teaches his students how to code and use information technology to tackle the issue of waste in the iconic Kampong Ayer community in Brunei. In designing an app to tackle trash buildup, not only did the students have to pay careful attention to their target users, they were also tasked to think about their potential interactions with relevant local authorities — important considerations in developing a sustainable solution. Finally, Dr Thi Kinh Kieu’s lessons on plastic value chains in Chapter 3.2 are aimed at changing students’ behaviour in generating plastic waste, by getting them to track and reflect on their own use of plastic before taking action to reduce plastic waste in their schools and homes.

While not every ESD lesson or curriculum needs to prompt students to take action, educators may find these chapters useful examples of what might be possible. After all, what is the purpose of education if not to empower individuals to step up, take ownership and address the pressing issues of the day?
3.1  
Designing self-watering planters for food security  
Ms Amanda Rachael De Souza & Dr Chen Liu Qi

In Singapore, the Applied Learning Programme (ALP) gives many students the chance to embark on creative projects that integrate and apply knowledge from across subjects. For Broadrick Secondary School, students made use of knowledge in Biology as well as Design & Technology class to create self-watering planters. Students not only made use of the concepts of plant biology and capillary action to create their planters, but also got acquainted with the design thinking process to improve their planter designs. This collaborative hands-on project also helped students work towards Singapore’s “30 by 30” food security goals, through growing their own edible greens at home.

**In this chapter, we learn:**
- What Singapore’s “30 by 30” food security goals are, and the Applied Learning Programme in public schools
- How to integrate biology and design thinking concepts in a hands-on project
- How to grow your own garden edibles through creating unique planters

**Sustainability in STEM and applied learning**

Many public secondary schools in Singapore have the Applied Learning Programme (ALP). It is a programme for students to connect classroom knowledge with real-world application, giving students a space to put skills and theory into practice. The ALP is non-examinable and emphasises knowledge application, critical thinking skills, problem-solving and stretching the imagination. Schools are able to choose the theme of their ALPs according to the following areas:
For Broadrick Secondary School, they have chosen the combined theme of *Entrepreneurship in STEM* and have embarked on integrated STEM ALP projects since 2017.

Collaborating with the STEM Inc. unit within Science Centre Singapore, Ms Amanda and her teaching team co-created the following ALP lesson resource according to Broadrick Secondary’s three-pronged ALP approach:

**Did you know**

STEM Inc. is the abbreviation for Science, Technology, Engineering, Mathematics (STEM); innovation and creativity, or Incorporation (Inc). Established in January 2014, it is a unit in Science Centre Singapore dedicated to igniting students’ passion for STEM.

Its initiatives are strongly supported by Singapore’s Ministry of Education as STEM Inc. supports the STEM Applied Learning Programme (ALP) in primary and secondary schools. One of the many ways STEM Inc. supports STEM ALP schools is through partnering with the end user — the school — in resource co-development. As a team, they collectively co-create teaching resources that meet the needs of the students’ profile in the school. Furthermore, the resources created could also be adapted and applied by other schools in the education ecosystem.

This lesson resource co-developed by Broadrick Secondary School and STEM Inc. explores the potential solutions for food sustainability and food security in Singapore by walking students through the process of creating self-watering planters.
Examples of self-watering planters in Broadrick Secondary School, built by its students

"30 by 30": Singapore’s aims for food security

Climate change and increasing geopolitical instability have impacted global food supply chains, and highlight the need for Singapore to have greater food resilience. As part of the Singapore Green Plan 2030, the nation is working towards a “30 by 30” goal: the ambition to produce 30% of her own food by 2030.

As a small island city-state with no natural resources, Singapore currently relies heavily on food imports; over 90% of her food supply is imported, with only 1% of state land available for agriculture. To attain the “30 by 30” goals, government agencies and agribusinesses in Singapore have worked closely together to innovate high-yield agricultural practices that minimises land use and leverages on technology. Practices such as hydroponics, aquaculture, and urban and indoor farming have gained prominence in recent years, with local agribusinesses increasingly circulating fresh produce into the markets.

As part of the Singapore Green Plan 2030, schools are activated to impart to students values of environmental stewardship for a sustainable future. Through their APL, students in Broadrick Secondary School learn about Singapore’s vulnerability to fluctuating food supplies, and understand how they can be part of the solution through growing their own edible greens.

“Our 30x30 vision is to grow enough food in Singapore to meet 30% of our nutritional needs by 2030.”
Masagos Zulkifli, Second Minister for Health, Singapore
The Design Thinking Process

During the course of the lesson, the students are encouraged to use the design thinking process to improve upon their self-watering planter design. Students are walked through this process during the 3rd lesson stage, after they have built their first planters. The design thinking process consists of five stages, with scaffolding built in at every stage to help students work towards their prototype:

1. **Empathise**
   - You may conduct interviews with your parents and neighbours to gather more information for this step of the design thinking process. Here are some suggested interview questions:
     1. Do you/your neighbours have plants at home?
     2. What are some challenges you face when keeping plants at home?
     3. What would make you want to grow your own edibles at home?
   - **What are your findings?**

2. **Define the Problem**
   - Let's come up with a problem statement based on the information you've gathered in the “empathise” stage.
   - E.g., “Some people don't like to keep plants at home because they find it a hassle to water them every day.”
   - **What is your problem statement?**

3. **Ideate**
   - Let’s focus on the problem statement and come up with ideas that solve the problem.
   - **What features would you like to include in your planter that address the problem statement?**

4. **Prototype**
   - Let’s incorporate the features you listed out in the ideate stage into a sketch of your prototype.
   - **What will your prototype look like?**

5. **Test**
   - It’s time to bring your prototype sketch to life and to test it out!
   - **What worked and what didn’t?**

Improved student planter designs after applying the Design Thinking Process
Building self-watering planters for edibles

The main topics covered in this lesson are:

The conditions required for healthy plant growth

How to apply the design thinking process to improve the design of a self-watering planter

Singapore’s “30 by 30” goal for food security

How to build a DIY self-watering planter from recycled bottles for growing edibles at home

Knowledge and Skills Reasons

**Knowledge and Skills**

From the lesson, students will be able to gain the following knowledge and skills:

- Students will understand conditions for healthy plant growth.
- Students will design and build a self-watering planter for growing edibles at home.
- Students will use design thinking to improve the design of their self-watering planter.
- Students will peer evaluate classmates’ designs and identify areas for improvement for their own designs.

- Students will be able to apply what they have learnt in the classroom to growing edibles.
  - Essential factors for photosynthesis: conditions required for healthy plant growth.
  - Capillary action: self-watering features.
- Students will gain an appreciation of creating an optimal self-watering planter through the design thinking process.
- The use of thinking routines and interactive learning features on the Student Learning Space (SLS) allows students to make interactions (student-content and student-student interactions).
VALUES
Through the lesson, students will cultivate the following values:

**Values**

Students will better appreciate the Singapore Green Plan 2030 and gain awareness of community and national issues related to the nation’s “30 by 30” goal.

**Reasons**

Everyone should play their part to contribute to the Singapore Green Plan 2030. Students will understand the “30 by 30” target and consider how they may be able to contribute to it via growing edibles at home.

Carrying out the lesson

SINGAPORE’S GREEN PLAN AND 30 BY 30 GOAL

To help students understand and gain awareness on Singapore’s Green Plan and the “30 by 30” goal, they were first shown an infographic and short videos on the Plan and the Singapore Food Story.

After going through the resources, students then answered the following questions:

1. Which key focus of the Singapore Green Plan 2030 do you think you can play a part in?
2. Do you and your family grow your own edibles at home?
Instead of traditional teacher-centred questioning, the first question was posed to the students using the Interactive Thinking Tool (ITT), a feature found in the Student Learning Space (SLS), while the second question was conducted via a poll. The incorporation of both tools was meant to increase student engagement in the learning process through the use of interactive activities and thinking routines. The ITT also encouraged self-directed learning by allowing students to add on to their peers’ responses using interactive thinking routines, which were intentionally added to facilitate collaboration.

Then, they attempted a fill-in-the-blanks activity:

For photosynthesis to take place, plants need to have 1) _________, a green pigment found in the leaves of plants. This pigment is found in the chloroplasts of plant cells.

Photosynthesis is the process where plants use energy from 2) _________ to make their own 3) _________.

The other factors required for photosynthesis are 4) _________ (a gas) and 5) _________ (the plant absorbs this from the soil).

The activity within the SLS has a self-grading function, which allows students to check for their own understanding. The activity ended with the question:

How can we ensure that plants receive a regular supply of water without needing to water them every single day?
BUILDING A SELF-WATERING PLANTER FOR GROWING EDIBLES AT HOME

A key scientific phenomenon underpinning the concept of the self-watering planter is **capillary action**. In transport in plants, capillary action refers to the upward movement of water from the roots to other parts of the plant and the leaves. The water eventually leaves the plant through the leaves via the process of evaporation, which helps to draw more water up from the roots.

**How capillary action works**

After students had learnt about capillary action, they were given the instructions to build their self-watering planters with a recycled bottle and a wick. The instructions came in the form of an infographic, and a step-by-step video.

**Tip**

Having different modes of instruction is a way to incorporate differentiated instruction in the classroom, so that students with lower readiness and visual/audio learners can be better supported in their learning.
Tip

For teachers to ensure this activity is successful the first time and avoid students getting discouraged, some preparation is necessary.

- Teachers interested in assigning this lesson package should try building the planter themselves and growing it from scratch (microgreens are the easiest).
- Teachers may want to pack some soil, seeds and wicks for students to bring home to complete the self-watering planter.
- Teachers may want to get students to bring their bottle caps to school to make the hole for the wick with a soldering iron. They can use a penknife or a pair of scissors to cut the bottle at home.

Examples of student-designed planters

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Student voice

“The lesson was enjoyable for me because I developed a love for plants earlier in the year. It was also fun brainstorming design ideas with my group mates and bringing our ideas to life. More importantly, it made me realise the importance of doing my part to make a change especially with climate change affecting our lives. If everyone made the effort to do something positive, it would really help us live more sustainably.”

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To encourage students to experiment and prototype, Ms Amanda conducted the lesson in collaboration with the school’s Design & Technology (D&T) team. As a result, students had the guidance and resources to ideate and construct unique planters made from wood and acrylics.

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REDESIGNING OUR SELF-WATERING PLANTERS USING THE DESIGN THINKING PROCESS

After students have built their first planter, they are encouraged to think about how the design can be improved. They were shown a video on the Design Thinking process and guided on how they could apply the five stages of the Design Thinking process.

As part of promoting student engagement, they were also encouraged to interview their family members and neighbours for feedback, and to take these feedback into consideration when improving their designs.
EVALUATION AND AREAS FOR IMPROVEMENT

Finally, students were tasked to upload a picture/sketch/drawing of their prototype onto SLS, and their classmates were prompted to provide feedback using the SCAMPER technique.

SCAMPER TECHNIQUE

S - Substitute
R - Rearrange/reverse
C - Combine
A - Adapt
M - Modify/magnify
P - Purpose
E - Eliminate/minimise

The SCAMPER technique is a brainstorming method useful for developing or improving products and services. By using this technique to provide feedback, students could obtain suggestions on how their planter prototypes could be enhanced.

BUILDING THE SELF-WATERING PLANTERS AND MONITORING PROGRESS

After having built their self-watering planters, students were directed to use the planters to grow edibles and share images using the ITT at 1-week, 3-week and 6-week intervals.

STUDENT FEEDBACK

Students tend not to be critical of their own ideas and of their peers’ ideas (for fear of hurting their feelings), and hence may not be able to give constructive feedback. This can be resolved by the use of the SCAMPER tool, which provides a useful framework in helping students give objective and constructive feedback to themselves and to their peers. In some cases, teachers may want to also look at each students’ work and give some prompts/feedback to facilitate the improvement of their designs rather than leave it all up to peer reviews.

STUDENT MOTIVATION

As with all home-based learning packages, some students will take their learning seriously at home while others may not. It is important for teachers to know their students and use various strategies to get students to put in the required effort to make this a meaningful learning experience. One way is to pair students up instead of setting individual work, get students to complete parts of the package in class and parts of it at home, with close monitoring from the teacher.
Teachers’ reflections on the lesson

As with all our ALP lessons, we try our best to invoke the joy of learning through the activities we assign our students. We try to keep the theory short but engaging and focus on the hands-on and collaborative components of the lesson to deepen learning. Over the years, we have had many students fondly recall the activities they completed during ALP sessions because of this aspect.

For this self-watering planter activity, it was only a success because of the teamwork of the STEM teachers, Design and Technology (D&T) and Entrepreneurship teachers.

The STEM teachers went through the impetus for the project, i.e., the 30 by 30 goal and basic scientific concepts applicable to the self-watering planters.

The D&T teachers were integral in getting students to apply the design thinking process to empathise, define, ideate, prototype and test out the designs; and ultimately, they were the ones who guided the students in the actual building of the prototypes in the D&T workshop.

The entrepreneurship teachers were then brought in also to develop our students’ 21st-century skills and to give them the time and space to hone their presentation skills (making slides and public speaking) for the “sales pitch” of the group designs to their peers in a classroom presentation.

All in all, the feedback from students was positive and they could articulate why they had to do this, how they worked together on their prototypes and how they felt confident to present their ideas to their peers.

One area for improvement would be the “what’s next”; i.e., for majority of the cohort, this remained a school project and the prototypes remained in school for display/recycling. As 2030 draws nearer and nearer, it is not enough for this to just be a school project. It should be something that every student can and will want to take home and share with their neighbours and friends to effect some real change to the prevailing food security issue we are facing in Singapore.

Hopefully, we will find a way to make the next iteration more meaningful to our students so that they will actually want to take it home and continue their planting stories and journeys.

- Ms Amanda Rachael De Souza & Dr Chen Liu Qi
Are you aware of the amount of plastics you use on a daily basis, and how it impacts the environment? Few people are, and this is an attitude that Dr Kinh is keen to change among students. This lesson introduces the concepts of a “plastic diary” and a “plastic diet”, and shows how students can bring about a behavioural change in themselves and also in their community through understanding the effect of plastics on the environment.

What happens to plastic?

A versatile, useful, and even essential part of our daily lives, plastics can be found everywhere. However indefinite plastic production and improper waste management has made plastics one of the biggest environmental pollutants and a major driver for petrochemicals.¹

In the typical life cycle of a plastic bottle that is not recycled, plastic ends up either:

1. **In a landfill**, where it mixes with rainwater to create leachate — a toxic waste product that pollutes the ground and water bodies.

2. **In the ocean**, joining the piles of accumulated plastics in one of 5 plastic gyres — giant plastic garbage patches like the Great Pacific Garbage Patch.

In this chapter, we learn:

- What the history of plastic is and how it negatively impacts the environment
- What the plastic value chain is and how we can stop plastic from entering the environment
- How students can maintain a “plastic diary” and reduce plastic consumption through a “plastic diet”

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To address the global crisis of plastic waste, concepts such as developing a circular economy and recycling gain prominence. A circular economy is an alternative to the current linear economy — where we take from the earth, make products, and dispose of them as waste. According to the Ellen Macarthur Foundation, a circular economy is based on three principles, driven by design:

1. Eliminate waste and pollution
2. Circulate products and materials (at their highest value)
3. Regenerate nature

Through adopting a circular economy we can aim to eliminate waste and close the loop on plastic waste leaking out into the environment while reducing our carbon footprint. Many economies such as Singapore have already taken steps to introduce aspects of a circular economy into the national development agenda, with initiatives such as the Zero Waste Masterplan.

Research has also taken to understanding and quantifying the plastic value chain, to track and incentivise plastic circularity. The main stages of the value chain are:

1. Raw material production
2. Manufacture of plastics and use
3. Disposal and end of life treatment

At each stage of the value chain, there are opportunities for more eco-friendly alternatives to plastics as well as circular waste management to reduce the amount of plastics ending up in the environment.

In the lesson plan below, Dr Kinh introduces the concept of the plastic value chain to her students, to help them understand their role in the value chain and take individual action to reduce plastic use.

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Reflective learning for changed behaviour

Keeping a diary and going on a diet are rather typical, everyday activities, but when applied in the context of plastic use, these are examples of reflective learning. One of the aims of the SDGs, and by extension, sustainability education, is to effect a change in behaviour at a global scale, and the classroom is an ideal place to realise this goal — starting at the individual level.

As the names suggest, keeping a “plastic diary” entails recording the type and amount of plastics used, while going on a “plastic diet” involves being conscious about one’s plastic consumption. Both activities require students to constantly reflect on their own actions, which would ideally in turn cause a change in the subsequent decisions and responses they make.

Behavioural change can be sustainable if it is grounded and informed by knowledge. Dr Kinh’s lesson demonstrates this by first laying a foundation of knowledge about plastics and “white pollution” (plastic pollution) before getting her students to critically evaluate their plastic use.

Going on a plastic diet to reduce plastic consumption

This lesson, while designed for university students, can be adapted for K-12 learners as well. Through first understanding how plastics are produced and how they can pollute the environment, students then learn how to put their knowledge into practical steps to change their behaviour.

Desired learning outcomes and lesson objectives

The main topics covered in this lesson are:

- History of plastic and its applications in our lives
- Plastic pollution (white pollution): From mainland to ocean
- Taking action: From plastic reduction to plastic-free

Author: Phan Văn Sĩ
Artwork Title: Fish

“Every year, plastic pollution in the ocean kills around 100,000 marine mammals, sea turtles, over a million species of seabirds, millions of fish and other species. Additionally, it has a significant impact on coastal communities and economies that rely on the ocean for their livelihoods. Indeed, plastic pollution in the ocean is at an alarming level.

Therefore, it is crucial to raise awareness about the severity of ocean plastic pollution. Now more than ever, it is necessary to minimise this by reducing the use of single-use plastics and transitioning to new biodegradable plastic materials that can replace traditional PP/PE.”

A student’s entry of the Plastic Diet Challenge campaign on Facebook
Image source: UEH Plastic Diet Challenge Facebook

Carrying out the lesson
The lesson begins with an introduction of the four main areas students need to understand:

1. The history of plastics and their applications in daily life
2. What the plastic value chain is
3. Why the use of plastics is a pressing issue
4. Solutions to reduce plastic pollution

INTRODUCTION to plastics and their environmental impact

VALUES
Through the lesson, students will cultivate the following values:

<table>
<thead>
<tr>
<th>Values</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>SELF-REFLEXIVITY</td>
<td>Students will commit to changing their behaviour to reduce plastic pollution.</td>
</tr>
<tr>
<td>RESPONSIBILITY AND PROACTIVENESS</td>
<td>Students will develop the conviction to communicate with their families, relatives and friends to reduce plastic pollution.</td>
</tr>
</tbody>
</table>

Knowledge and Skills
From the lesson, students will be able to gain the following knowledge and skills:

<table>
<thead>
<tr>
<th>Knowledge and Skills</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students will understand the plastic value chain.</td>
<td></td>
</tr>
<tr>
<td>Students will understand the adverse impact of plastic waste leakage into the environment, by observing and exploring areas with plastic pollution in their own community.</td>
<td></td>
</tr>
<tr>
<td>Students will be able to measure and quantify the amount of plastic used in their daily lives.</td>
<td></td>
</tr>
</tbody>
</table>

• Urbanisation and modern life result in the “convenient trade” of numerous single-use-plastic items. Therefore, it is important that students are aware of the adverse impact of single-use plastic on the environment, particularly the ocean, where marine biodiversity is in endangered. This pedagogical goal will be accomplished through lecturing and mass media.

• Students need to develop higher-order evaluative skills to evaluate the plastic use in their daily lives and to change their individual behaviour towards sustainable consumption. This pedagogical goal will be accomplished through hands-on activities.

KNOWLEDGE AND SKILLS
From the lesson, students will be able to gain the following knowledge and skills:
Students are guided through a series of resources to help them understand these concepts:

### a. The history of plastics and their applications in daily life

**Tip**

A participatory approach should be used in the lesson through Q&A and focus group discussions, in addition to lectures. The use of videos, infographics, and social media content helps students to better visualise concepts and engage with the content.

**3 Important things!**

Every single category of plastic could leach hazardous materials if put in an extreme situation such as extreme heat.

- 3 types of plastic that are considered as safer options for food: Terephthalate (PET), High-Density Polyethylene (2-HDPE), and Polyproplene (6-PP).

Currently, only 2 types of plastic whose recycling technology is more advanced in Indonesia, Polyethylene Terephthalate (2-PET) and High Density Polyethylene (2-HDPE).

**Tip**

A participatory approach should be used in the lesson through Q&A and focus group discussions, in addition to lectures.

The use of videos, infographics, and social media content helps students to better visualise concepts and engage with the content.
c. Why the use of plastics is a pressing issue

From the 1950s to 1970s, plastic waste was manageable due to the small scale of production and consumption of plastic items. However, plastic pollution first emerged as an issue in the late 1960s and early 1970s, and in the three decades that followed, plastic waste generation more than tripled. In the early 2000s, the amount of plastic waste rose more in a single decade than it had in the previous 40 years. Today, the world produces about 400 million tonnes of plastic waste annually. That is about the weight of 53 million elephants!

d. Solutions to reduce plastic pollution

You might be familiar with the 3Rs: Reuse, Reduce and Recycle. Did you know that there are also the 5Rs and the 7Rs? These are solutions applied worldwide to mitigate the impact of plastic pollution.
2. BUILDING A PLASTIC FRAMEWORK

After the introduction, the class will be split into groups to work under the teacher’s supervision. Their task is to build a plastic framework that sums up the knowledge and lessons learnt from the first session. To facilitate the discussion, the “5W1H” technique will be used:

The “5W1H” exercise will reinforce students’ understanding and provide them with a comprehensive picture of plastic waste. This will help to enhance the students’ systems thinking competency. Systems thinking and learning organisation is more than holistic or comprehensive thinking competency — it is the ability to recognise and understand relationships; to analyse complex systems; to think of how systems are embedded within different domains and scales; and to deal with uncertainty.

**WHO:** Identify the people and parties involved in every step of the plastic value chain, including but not limited to producers, suppliers (local markets, supermarkets, stores, etc.), consumers, plastic waste collectors (formal and informal), and recyclers.

**WHAT:** Identify what is produced, supplied, consumed, collected, and recycled, including what is not collected.

**WHEN:** Briefly summarise the development of plastic pollution.

**WHERE:** Identify the global and local areas that are plastic hotspots.

**HOW:** Explain how plastic pollution can be reduced.

**WHY:** Explain and predict the adverse consequences of plastic leakages.

**5W1H**

**Building a plastic framework with 5W1H**

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**KEYWORDS**

**Systems thinking:** a “holistic approach to analysis that focuses on the way that a system’s constituent parts interrelate and how systems work over time and within the larger context of systems. The systems thinking approach contrasts with traditional analysis, which studies systems by breaking them down into their separate elements.”

By getting students to map out the entire life cycle of plastic and the various stakeholders involved in producing and using plastic, Dr Kinh exercises students’ systems thinking skills by getting them to think about the whole picture.

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**Infographic on the history of plastics**

*Image source: Plastic Collective*

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*Ben Ludkevich, “What is systems thinking?” Tech Target CIO, March 31, 2023, https://www.techtarget.com/searchcio/definition/systems-thinking*
b. Plastic pollution overview

Infographic on the impact of plastics on the environment
Image source: CPR Asset Management

Through the activity, students are guided on sourcing facts about plastic in their own localities, to develop a plastic framework specific to their city or community. They can find, for example, the specific plastic-related stakeholders such as producers, retailers, consumers and recyclers in their community.

FOLLOW-UP ACTIVITIES

After the class, students will be tasked with two follow-up activities focused on building student awareness of single-use plastic waste generated from everyday activities. These are:

a. Plastic count
b. Plastic diet diary and Facebook challenge

a. Plastic count

Students are required to count their families’ plastic disposal every day (for a week) using the worksheet given. They will also calculate the average amount of plastic waste generated in their town or city every day, month and year, and compare their statistics with their classmates.

The worksheet students fill up to count their plastic use
Image source: The Big Plastic Count
b. Plastic diet diary and Facebook challenge

Each student will detail their roadmap to reduce plastic pollution (applying 3R, 5R, 7R) and create their own plastic diet diary (using notes, paintings, videos, etc.), to record the steps they take each applying these principles to reduce plastic use. They use this in conjunction with their daily plastic count, to keep track of how much single-use plastic they use over time, and to build awareness of how they can reduce individual plastic waste.

Mon: Exam starts at 7 a.m

Today is the beginning of the week, like all other Mondays, I have an exam at 7 a.m. and it takes me a good 30 minutes to drive from home to campus. Perhaps I should buy a bánh mì as a quick breakfast, saying goodbye to my beloved My Quang (a Vietnamese noodle dish), as I simply don’t have the time. Mrs. Phuong, the bread vendor near the campus must be in her sixties by now. She recognizes me as a regular customer, knowing that I often grab a sandwich when I am short on time. As usual, she wrapped my bread in paper and handed it over to me. With other customers, she would then wrap it again with a plastic bag on the outside but leaves out the plastic bag for my orders. She must be so accustomed to my refusal of using plastic bags. Perhaps that’s why she remembers me the most — a sophomore who never accepts plastic bags. Time is running out, I need to rush to class to make it on time for the exam...

Tue: No exams for today

I go to the supermarket three times a week: on Tuesdays, Fridays, and Sundays. Today was the first grocery shopping day of the week. Since we go to a wholesale store, they don’t provide free plastic bags. You have three options for packing your items: Option 1 is to use the cardboard boxes of various sizes available near the parking lot. Option 2 is to bring your own bags or containers. And finally, option 3 is to buy their reusable bags for future shopping trips.

I really love this aspect of the supermarket. And of course, I always keep a large plastic basket in the trunk of my car, ready to go. It’s so convenient. It has become an indispensable companion of mine during shopping trips. My loyal three-year-old friend.

Wed: No exams for today

Another beautiful day has arrived, and today I didn’t have a final exam. This morning, I treated myself to a deep sleep until 9 a.m. I woke up, freshened up, and then headed downstairs to the kitchen. To my delight, I found that my mother had prepared a bowl of Bun Bo Hue for me, which is my favorite. Our family has abandoned the habit of buying items in plastic bags, and instead, we bring our own personal containers for breakfast take-away.

In the afternoon, I took the opportunity to visit the Peanut Coffee Shop near my house to review my lessons for tomorrow’s exam. This place is my favorite, not only because of its clean and airy ambiance but also because of the beverages they serve. Here, they exclusively use glass mugs and glass cups instead of plastic ones. Paper straws or glass straws replace the typical plastic ones. Another thing I love is that for take-away customers, they always provide paper cups instead of plastic cups, which is very environmentally friendly. The owner of the shop shared with me that he used to be an environmental engineering student at my university, which means he is my senior. Therefore, he deeply cares about environmental issues, especially in terms of sustainability.
These follow-up activities are meant to enable students to explore their daily plastic consumption (particularly single-use plastic) and experience the challenges of going on a “plastic diet”. By getting students to bring this challenge to their community, it is hoped that they can effect a change in lifestyle and spread sustainable habits.

It is hoped that this experience will get students started on their sustainability journey by changing perceptions of and behaviour towards single-use plastic, reducing the generation of plastic waste.

At the end of the challenge, the teacher leads students to reflect on how the activity has changed their perceptions of plastic, and how the activity has changed their use of plastic in daily life.

Reflective questions include:

1. Can you compare your plastic use with those of your classmates and family? How does it compare?
2. Do you want to reduce your use of single-use plastics in daily life? What was your experience in trying to reduce your plastic count? Was it easy, or even possible?
3. How long do you think any change in behaviour will last? Will you be able to sustain a lifestyle with reduced plastic use?
4. What were some challenges in going on your plastic diet?
5. Were there things you did to overcome those challenges? Do you see those challenges persisting in daily life?

Students exchanging their plastic wastes for “green gifts”

Image source: UEH Plastic Diet Challenge Facebook

Common actions taken by students to reduce their plastic consumption were:

- Using lunch boxes over styrofoam boxes
- Refilling their water bottles over buying bottled water
- Avoiding using wet tissues constructed by fibre plastic
- Using a cotton bag over single-use plastic bags

The Plastic Diet Challenge campaign on Facebook run by the University of Economy Ho Chi Minh City (UEH)
I have witnessed the effectiveness of the interactive pedagogies in enhancing students’ knowledge and skills. Searching for resources and shaping a new lesson may consume much time and energy at first, but teachers will feel that it is worth it when they see how it changes students’ perceptions and inspires them to lead a more sustainable lifestyle.

Students’ performances after the lesson and their exercise submission will strengthen teachers’ faith and hope in sustainability. Teachers can be seen as key actors to transform the society. The follow-up activities can provide strong evidence to show how educators may contribute to sustainability.

- Dr Thi Kinh Kieu

**Teacher’s reflection on the lesson**

In reflecting on how the challenge had changed their perceptions and use of plastic, students expressed that:

- Changing their behaviour to use less single-use plastic was difficult, and they had to be conscious to change their habits; with practice and more time, these would become habitual actions for them.

- Single-use plastic is very cheap and makes things convenient; however, the challenge made students conscious of just how much plastic waste they generated in a day just from small daily actions like buying food and bottled water.

- More can be done to regulate plastic use on a policy level, such as banning certain plastic types as other economies have done.

The teacher then concludes the lesson by summarising common challenges the class faced in reducing their plastic use during the activity, and steps they can take to sustain their behaviour to reduce daily plastic use. The teacher can also summarise the overall challenges of reducing plastic pollution, and reaffirm that individual action can contribute to a big change in global plastic consumption and pollution.

**Challenges and solutions in lesson implementation**

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Potential solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIME CONSTRAINTS</td>
<td>Teachers should provide and explain clearly the worksheet and time needed for each activity.</td>
</tr>
<tr>
<td>LIMITED ACCESS TO SOCIAL MEDIA</td>
<td>Teachers may flexibly change the challenge to one that is offline in nature.</td>
</tr>
</tbody>
</table>
3.3
Tackling coastal erosion in the backyard
Ms Suwaida Lahama, Ms Mareeyoh Saemahsae, Ms Isara Narawong, Ms Rosakimi Hayee-arong & Ms Aswanee Mathawee

For many students, learning about environmental changes and geography remains theoretical knowledge, especially when living in an urban environment. For Ms Aswanee and her colleagues at Narathiwat School, encountering the real and persistent threat of coastal erosion happening in the school's backyard forms the basis of their lessons in sustainability. This chapter showcases how Ms Aswanee and her colleagues designed a practical solution to coastal erosion and proposed sustainable coastal protection measures at the school's coastline, by designing and conducting an integrated STEM unit.

Coastal erosion and changing coastlines
Coastal erosion refers to the permanent loss of sediments in coastal zones. This is caused by processes such as increasing sea levels, strong waves and coastal flooding, which lead to shrinking coastlines.

Coastal erosion can be attributed to natural processes and human activities. As communities develop, people modify their surrounding landscapes to make room for human settlement and activity. Natural ecosystems that help maintain coastlines, such as dunes, vegetation and mangroves, are removed to make way for land use. The construction of man-made structures has affected the natural erosion cycle, altering sediment flow for deposition to the shore. Other human activities include groundwater extraction, which — if excessive — causes significant subsidence and results in coastal erosion.

The biggest natural component causing coastal erosion is waves, formed by winds. Waves hit the coast at certain angles, and sometimes erode and transport sediments away. This process of erosion caused by waves is exacerbated by storms, where strong winds produce large, high-energy waves that remove even more sediment from the coast.
The anatomy of a wave

All waves induce swashes and backwashes. A swash is a wave that washes onto shore, moving sediments like rocks and soil onto the coast. A backwash is a wave that recedes into the sea, taking sediments from the coast.

A wave with a stronger swash than backwash is called a **constructive wave**. Constructive waves help with the deposition process, which refers to the accumulation of sediments that build the coastline.

Conversely, a wave with a stronger backwash than swash is termed a **destructive wave**. Destructive waves lead to coastal erosion, removing material from the coastline.

Coastal erosion along the Gulf of Thailand

Coastal erosion has long affected Thailand, a country with a long coastline of over 2,600 kilometres, bordering the Andaman Sea and the Gulf of Thailand. The Gulf of Thailand spans 1,900 kilometres and encompasses 17 coastal provinces, including Narathiwat. These coastal zones support Thailand’s booming tourism industry, with many travellers visiting beaches and resorts.

Shrinkage of Bangkok’s coastline over the years

Image source: ClimAdapt

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*Royal Thai Consulate-General, Los Angeles, Thailand in Brief (ประเทศไทยในเริ่มต้น), November, 2022, https://thaisoutheast.a.th/embassy-eng/page/thailand-in-brief*
Thailand’s rapid industrialisation has contributed to its shrinking coastline, which has shrunk by 22% over the past 30 years. Removing natural ecosystems such as dunes and mangroves for land use near the shore has accelerated natural erosion rates. Local communities and biodiversity have been impacted by coastal erosion in many ways:

**LOSS OF LAND**
Decreasing living space and land for human activities; shrinking of coastlines have displaced residents and their livelihoods, such as fishing and tourism.

**PROPERTY DAMAGE**
Incurring economic losses for compensation, reconstruction.

**HIGHER RISK OF FLOODING**
Permanence in the rise of sea levels; by 2070, there will be an increase from 1 million to more than 5 million residents who are vulnerable to the threat of flooding in Bangkok, a low-lying city in Thailand.

**DESTRUCTION OF BIODIVERSITY AND MARINE LIFE**
Loss of animal habitats such as marshlands and beaches.

While coastal erosion frequently affects nations and communities, there are common solutions to mitigate its impacts. Coastal erosion is mainly tackled in two ways: hard and soft engineering solutions.

In the Thai coastal community of Khun Samutchine, for example, rising water levels have been creeping into land and threatening the existence of an important religious shrine. This Buddhist temple is an integral part of the community, and many villagers are reaching out for help to save the temple from further erosion.

Example of destroyed houses caused by coastal erosion
Image source: Manish Kumar/Mongabay

Common solutions to coastal erosion

Example of destroyed houses caused by coastal erosion
Image source: Vinai Ditthajone/Greenpeace

In this chapter, we see how students of Narathiwat school went through an inquiry process to help them understand the causes of coastal erosion in their community, and then evaluate the best engineering solution to combat coastal erosion.
An integrated STEM approach to combat coastal erosion

Narathiwat School is a secondary school located on the east coast of Narathiwat province, Thailand. Uniquely, the school is located just metres away from the coastline. The government’s construction of breakwaters at Narathat Beach has unfortunately resulted in the loosening of sand sediments of the sea behind the school. Where there used to be a mangrove forest, the seaside area behind the school has become shallow, with waters encroaching upon school grounds. Although there have been additional breakwaters constructed for the community, such constructions are evidently not long-term solutions, affecting currents and seawater quality.

Faced with a time-sensitive problem to safeguard the coast and school grounds, students were challenged by Ms Aswanee and her fellow teachers to come up with viable solutions to protect the coastline through an integrated STEM project to develop effective defence prototypes to combat destructive waves.

While students’ proposals did not ultimately reach the appropriate governing department to exact their proposed coastal management methods, the entire unit was extremely eye-opening and formative for students. They internalised the scientific process and problem-solving skills, using them to address immediate environmental concerns and feel empowered to initiate effective solutions to change the world around them.

To be able to design an effective defence prototype, students had to learn about and understand the problem of coastal erosion. Being a multi-faceted issue, covering this topic required more than one lesson. The following diagram shows an overview of the knowledge from different subjects needed in order to create an effective prototype.
Narathiwat School is located along the coast of the Gulf of Thailand. Every year, coastal areas gradually disappear due to erosion. Therefore, it is necessary to find a sustainable solution to the erosion problem in order to protect the area where the school is situated, the coastal ecosystems, the surrounding residential areas, and the workplace areas of the locals from disappearing. The evidence and understanding of the science behind the wave properties of materials are used to create the prototype.

**SCIENTIFIC KNOWLEDGE**
- Wave properties
- Properties of materials used to make the coastal erosion defence prototype
- Coastal ecosystems

**PROBLEMS (STEM)**
Narathiwat School is located along the coast of the Gulf of Thailand. Every year, coastal areas gradually disappear due to erosion. Therefore, it is necessary to find a sustainable solution to the erosion problem in order to protect the area where the school is situated, the coastal ecosystems, the surrounding residential areas, and the workplace areas of the locals from disappearing. The evidence and understanding of the science behind the wave properties of materials are used to create the prototype.

**MATHMATICS**
- 3-dimensional volume
- Scale
- Beach slope
- Calculations

**TECHNOLOGY**
- Motor (wave source simulation)
- PhET programme
- Data collection tools

**ENGINEERING**
- Design and create the coastal erosion defence prototype

Investigating wave properties in a tank and making a wave source to create the coastal erosion defence prototype that is suitable for the context of the coastal ecosystem of the community.

Ms Aswanee and her colleagues made use of the STEM Quartet framework to create their integrated STEM lesson that addressed coastal erosion.

Calculating the area, material and size to create the prototype.

The affordances of technology that can be used to enhance the design of the solution and can be used to build or create the prototypes based on study and research.

Photos from Narathiwat school showing the coastline protection built by the government.
Designing a Coastal Defence Prototype

The following unit plan outlines the different activities carried out over a period of time, with these activities designed as scaffolding to guide students to eventually creating the prototype.

These activities are broadly classified into three phases:
1. Understanding the problem of coastal erosion
2. Understanding what is wave property
3. Building the coastal defence prototype

Desired learning outcomes and unit objectives

The main topics covered in this unit are:

- Causes of coastal erosion and wave properties
- Common solutions to coastal erosion in both hard and soft engineering
- Design and prototyping solutions to coastal erosion

KNOWLEDGE AND SKILLS

At the end of the lesson, students will be able to:

<table>
<thead>
<tr>
<th>Knowledge and Skills</th>
<th>Reasons</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Knowledge and Skills</strong></td>
<td><strong>Reasons</strong></td>
</tr>
<tr>
<td>Analyse areas affected by and causes of coastal erosion in their local area and in Thailand.</td>
<td>By recognising and understanding the problem of coastal erosion, students will be able to develop an awareness and appreciation for the natural resources available in their community.</td>
</tr>
<tr>
<td>Identify community problems related to coastal erosion.</td>
<td>Students can learn to analyse, synthesise and discuss the problems and factors related to coastal erosion together. By doing so, they can learn to empathise with the well-being of the people in their community.</td>
</tr>
<tr>
<td>Describe the properties of waves that lead to coastal erosion.</td>
<td>Students can learn to classify, explain and share their knowledge about each wave property, in the process learning to accept the opinions of others.</td>
</tr>
<tr>
<td>Research and discuss on the topic of natural and man-made coastal defence barriers that have affected the ecosystem.</td>
<td>Students will be able to develop skills in the critical use of technology to search for information and reliable references.</td>
</tr>
</tbody>
</table>
Select suitable materials to create a coastal erosion defence prototype.

Students will have the opportunity to apply their knowledge and choose the type of material to use for the breakwater, taking into account its value and durability in use.

Design and create a coastal erosion defence prototype and test its effectiveness.

Students will be able to invent, develop and integrate their knowledge of coastal erosion to creatively design and model solutions that are efficient, durable, sustainable and have minimal impact on the surrounding environment.

VALUES

Through the unit, students will cultivate the following values:

<table>
<thead>
<tr>
<th>Values</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>CREATIVITY, INNOVATION, AND CITIZENSHIP</td>
<td>Students should grow the mindset of good citizenship that would benefit the security and sustainability of the community.</td>
</tr>
</tbody>
</table>

Carrying out the integrated STEM lesson

**Phase 1: UNDERSTANDING THE PROBLEM OF COASTAL EROSION**

Prior to the lesson, teachers had revised the knowledge students learnt in Grades 7–10, such as the wave properties that caused coastal erosion and ways to reduce wave energy to prevent erosion.

Inspired by the famous Thai game show *Fan Phan Tae*, meaning “True Fan”, students were grouped into fours to play a game. The game quizzed students on how much they knew about Narathiwat School and their surrounding environment, with students getting the right answers proving they were “True Fans” of the school.

Activating prior knowledge

**Instructions**

01. Ms Mareeyoh would show pictures of coastal areas in Narathiwat.

02. Students had to correctly identify these coastal areas closest to Narathiwat School.

03. Students had to answer quickly in order to win the game, to prove they were “True Fans”. The whole game lasts only 2–3 minutes.

**Objectives**

01. Activate students’ background knowledge of coastal erosion.

02. Expose students to the coastal erosion problem taking place in their immediate vicinity.

03. Expose students to the coastal erosion problem taking place in their immediate vicinity.
The game allows students to get familiar with images of locations close to the school that they will visit in subsequent lessons, and prepare them for what problems these areas face with regard to coastal erosion.

Students are grouped to discuss the question, comparing their answer with their peers before sharing their thoughts to the whole class. With the class's conclusion being severe coastal erosion, this sets the context for the lesson unit and later activities.

This activity prepares students for the next activity, which is when they would go on a field trip to different communities along the coast, and collect data and testimonials about how coastal erosion has affected the community from people living along the coast. The teacher first briefs students on the places and people they will visit.

Students were divided into groups and brainstormed questions to ask these communities based on the information they wanted to gather. Each group presented their questions to the whole class.

Afterwards, Ms Mareeyoh and the students discussed the viability of the questions and the students voted for which ones were to be used for the survey. Through the activity, the following categories for crafting survey questions had come up in the discussion:

1. The living conditions of the villagers
2. The problems of coastal erosion in Narathiwat Province
3. The effects of coastal erosion in Narathiwat Province
4. The solutions from the public and private sectors

After giving the background of the coast near Narathiwat School, Ms Mareeyoh showed a timelapse of the area throughout the years, exemplifying the shrinking coastline.

With the students being introduced to the coastline in their vicinity, Miss Mareeyoh posed a scenario to them:

“From the images of the coastline, what do you think will happen to the coastal area behind the school in 20 years?”
3. FIELD VISITS TO COASTAL COMMUNITIES ALONG NARATHIWAT

After crafting their survey questions, students were brought on a field trip to visit four communities living along the coastline. Students were required to complete three main tasks during their field visit:

- Take photographs of different types of engineering interventions used to mitigate erosion at three sites.
- Take pictures of coastal areas that have been damaged in different ways at each location.
- Interview locals on the different ways coastal erosion has affected their daily life and/or their occupation.

Although the students had the same tasks to complete, there were different objectives at each location:

01 Baan Bage: As some villagers still live here and a new breakwater is being constructed, students can inquire about how coastal erosion have affected community leaders and the area they live in.

02 Narathiwat Beach: A tourist attraction, Narathat beach houses a big community of fishermen. It is also the main area where breakwaters are constructed, causing the issue of sedimentation and erosion. The students can interview the villagers who have experienced the changes of the beach overtime.

03 Ao Manao Beach: At Ao Manao, there are fewer people and no breakwaters, hence students are encouraged to observe the geography of the area, waves and wind affecting coastal erosion, with the guide of the teachers and engineers.

04 Irrigation Office of Narathiwat Province: Students can study more about the causes of erosion and the projection policy that the government have here. At this location, students should be able to compile their findings from the survey, preparing to discuss and share their findings with the whole class.

Students measuring the slope of the beach at Ao Manao to see how waves cause coastal erosion.
After concluding their survey findings at the field site, the students started the next lesson learning about coastal erosion in the region.

The groups were tasked to review the data collected from their trip alongside class material to supplement their findings. At the end of the lesson, each group presented their findings on:

- The problems that occur at each field site
- The effects of coastal erosion on these areas
- Potential coastal defence strategies

After presenting, all groups went through a round of questions with the class, responding to any queries their classmates had regarding their findings.

This synthesis of knowledge allows students to understand the larger picture of how coastal erosion impacts various communities along the entire coastline.

Students then watched a news video clip on coastal erosion in Thailand. The video prefaced the predicament of Thailand’s shrinking coastlines and the urgency to address it.

In our STEM education, we were encouraged to search for information before each class, and to share our findings with our classmates. Through this process, we learned to gather information from multiple sources, which helped us develop critical thinking and information-filtering skills. This enabled us to distinguish between highly reliable and less reliable sources of information.”

To help raise the students’ awareness of the impact of coastal erosion in a bigger context, they were posed focus questions by Ms Isara:

1. What can you see from the video?
2. From the video, how does coastal erosion happen?
3. What factors affect coastal erosion?
4. How do you think coastal erosion affects coastal ecosystems?
5. From the video, how are you going to prevent coastal erosion?

These questions facilitated discussion among the students, testing their knowledge on the effects of coastal erosion as well as measures to manage them.
6. CONDUCTING A WAVE SIMULATION EXPERIMENT

The students were guided by Ms Mareeyoh in designing and planning experiments to help them understand the impact of wave action on the shoreline. In so doing, they practised scientific process skills such as:

- **Formulation of problems and hypotheses**
- **Identification of variables**
- **Conducting of experiments**
- **Analysis of results**
- **Data collection**
- **Sharing and discussion of findings**

At the end of the lesson, students would be able to conduct an experiment and compare how the coastline would change when the wave strength is different. Firstly, students brainstormed a plan for an experiment to simulate waves based on the beaches they explored in previous lessons. In their groups, they had to come up with flowcharts, problems and potential hypotheses to discuss with the class. Students then decided the materials to build their mock-up beach, of a height no more than 25cm and water level with an altitude of 10cm. Once they finished creating their mock-up beach, students conducted the experiment of testing waves of different energy levels, recording down their results.

The results of the experiment were summarised as follows:

- **Stronger waves will erode the coast more than weaker waves.**
- **Waves hitting coastal areas that have coastal barriers will cause lesser erosion than coastal areas without barriers.**

Representatives were randomly chosen to present their group’s results and students were provided an opportunity to ask questions and give suggestions on interesting findings. Based on the students’ sharing, teachers were able to assess students’ understanding of the experiment outcomes.

After the experiment, students match their observations of waves from the previous lesson to theory on wave property. Using the jigsaw technique of learning, students collaboratively studied wave properties of:

- **Interference**
- **Diffraction**
- **Reflection**
- **Refraction**

Students' experiment design and prototypes
Jigsaw learning was chosen to ensure that all students understood the content and reached the same conclusions. In this approach, each student in the group was assigned to read up on and understand a specific topic. After this, the students took turns to share what they had learnt to their peers in the group. During the activity, Miss Suwaida set an appropriate timing and encouraged the students to exchange ideas with each other as much as possible.

Having understood wave properties, each group was then tasked to study different types of wave barriers, or various methods of prevention and natural remedies for coastal erosion, including hard and soft engineering methods. Students conducted research on the characteristics, advantages, and disadvantages of these different wave barriers, and were tasked to put their findings up on a poster board. The wave barriers discussed were:

- Beach nourishment
- Bamboo fences
- Revetments or seawalls
- Groynes
- Dams
- Making sand-bag sausages
- Planting mangroves
- Headlands
- Jetties

All the groups then shared their information through a gallery walk. After considering the pros and cons of each wave barrier, each group ranked the effectiveness of the wave barriers that best fit their context, even combining some of these solutions if it worked better.
Top solutions ranked by the students to suit Narathiwat School’s coast, and their reasoning:

**REVETMENT**
The structure is strong enough to protect the coastline.

**GROYNE**
A coastal management solution that is friendlier to the environment.

Through the ranking activity, the students gained the opportunity to develop critical thinking skills and communication skills as they debated the rankings in their groups.

Considering how clearly defining roles and responsibilities within a group and time management were important skills for students to develop, Ms Isara provided guidance and support to help students stay on track and complete their work within the given timeline.

**Phase 3:**
**Building the Prototype**

After deciding on the best coastal protection strategies implementable for their school, students go on to test out the effectiveness of these barriers.

To engage the class in this activity, Ms Suwaida facilitated a role play, prompting the students as “engineers” who have to design and build coastal barriers to solve the problem of coastal erosion of Narathat Beach.

The students were to brainstorm ideas in their groups based on these two conditions:

1. Barriers that are durable and long-lasting
2. Barriers that have the least impact on the surrounding environment and local ecosystem

In their groups, students were to:

- Decide their client group
- Outline the agenda of what they had to solve
- Consider materials and devices required to construct their solutions
- Delve into research for potential solutions
Time was given to the students to discuss their ideas within their groups, collaborating to establish the criteria for evaluating the effectiveness of their solutions.

After the discussion, Ms Suwaida provided the groups guidelines for building their prototypes and the materials they were provided with. Students were free to bring other equipment or materials as well, allowing for a variety of work pieces to be produced.

Based on the information and material students have learnt and sourced, students could take charge of their own learning, having been given the autonomy to construct and test a 3D model.

GUIDELINES
- Beach height not more than 25 cm
- Beach length not more than 55 cm
- Sea water with an altitude of 10 cm

List of materials provided per group:

- A tank (30 cm x 122 cm x 30 cm)
- Hot glue gun
- Plastic board (67 cm x 96 cm, 2 mm thick)
- Measuring Tape
- Plasticine (20 pcs)
- Gravel/Pebbles (1 kg)
- Coarse sand (1 kg)
- Lego (1 set)
- Stone (1 kg)
- Soil (1 kg)
- Plain water (10 litres)
- Plaster (1 bag)
- Food colouring (2 colours)
- Phone/camera for recording
- Wave simulation set (from the previous experiment conducted)
- Post-it notes
- Whiteboard markers
- Large sheet of paper

Once the students were done building the prototypes, each group tested the efficacy of their prototypes and record their results.

Having designed and tested the first iteration of their prototypes, the students were then divided into two groups to discuss the following questions using the fishbowl technique.

This technique involves one group of students sitting in an inner circle and engaging in a discussion while the other group of students sit in an outer circle and take notes on the discussion. To prepare for the fishbowl activity, the students first practised with a hot seat activity, where one student is interviewed by the rest of the class.
Once the activity was completed, the students were given time to discuss which prototype they liked best outside of their own group. Each group was given fake banknotes to award to groups they felt had the best defence prototypes. The winning group with the highest number of banknotes received a prize.

Finally, the students presented their defence prototype in a mock sales competition supervised by Ms Suwaida. Other teachers, administrators, and engineers also attended, walking around to watch and listen in on their presentation.

All groups split themselves into pairs that took turns in:

- Pitching their prototype to their classmates and responding to queries.
- Visiting their classmates’ stations to learn more about other groups’ prototypes.

Each group then presented their defence prototype and suggested ways to improve its effectiveness. Afterwards, groups were given time to reflect and refine their prototypes.

By actively listening to each other’s ideas and working together to discuss ways to develop, fix, and innovate solutions, students also developed their presentation skills.

The guiding questions for the activity were:

- Who is the client you are solving the problem for?
- What is the problem?
- What is the solution to the problem?
- How do you identify the solution to be used?
- Is your prototype successful or not?
- If your prototype works, why do you think it is successful?
- If an innovation fails, what might be the reasons?
- How can you improve your work?

Tip

Small group discussions can facilitate collaborative learning. By allowing students to gather input from their peers, this supports the active construction of ideas. The students can learn from one another to improve their model.
<table>
<thead>
<tr>
<th>Creative Dimension</th>
<th>Criterion</th>
<th>Score 1</th>
<th>Score 2</th>
<th>Score 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Novelty</td>
<td>GERMINAL</td>
<td>Lower level of germinal: The product inspires others with the creation.</td>
<td>Medium level of germinal: The product inspires others to try something new.</td>
<td>High level of germinal: The product inspires others to try something new, by directly offering ideas for development.</td>
</tr>
<tr>
<td></td>
<td>ORIGINAL</td>
<td>Lower level of originality: Students mostly use the previous finding as their product idea.</td>
<td>Medium level of originality: Students use the previous finding as their idea, but they need to make a modification of the product.</td>
<td>High level of originality: The product idea comes from students' own understanding.</td>
</tr>
<tr>
<td>Resolution</td>
<td>VALUABLE</td>
<td>Lower level of valuable: The product is not compatible with the purpose and does not relate to the concept.</td>
<td>Medium level of valuable: The product is compatible with the purpose but does not relate to the concept.</td>
<td>High level of valuable: The product is compatible with the purpose and relates to the concept.</td>
</tr>
<tr>
<td></td>
<td>USEFUL</td>
<td>Lower level of usefulness: The product can be used once.</td>
<td>Medium level of usefulness: The product can be used continuously only when certain requirements are met.</td>
<td>High level of usefulness: The product can be used continuously without any additional requirements.</td>
</tr>
<tr>
<td>Elaboration</td>
<td>EXPRESSIVE</td>
<td>Lower level of expressive: The product is not presented in an understandable manner, and lacks effective delivery and body language.</td>
<td>Medium level of expressive: The product is presented in an understandable manner, but lacks effective delivery and body language.</td>
<td>High level of expressive: The product is presented in a communicative way using effective body language and clear voice, and conveyed in an understandable manner.</td>
</tr>
<tr>
<td></td>
<td>WELL-CRAFTED</td>
<td>Lower level of well-crafted: The product is done well.</td>
<td>Medium level of well-crafted: The product is done well with a good-looking design.</td>
<td>High level of well-crafted: Students take an effort to give interesting product design by using some materials.</td>
</tr>
</tbody>
</table>
Tip
It is important for students to understand their roles and responsibilities in the activity, and for the teacher to provide clear guidance on the expectations for both “buyers” and “sellers”. Additionally, setting an appropriate time limit can help keep the activity focused and on track.

Potential challenges in implementing the unit

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Potential solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>WORKING IN A DIVERSE TEAM</td>
<td>Through time, the teachers gradually adjusted to the changing situation. They also actively helped one another find solutions as they received support and encouragement from administrators, other teachers in the school and good advice from SEAMEO STEM-Ed experts. The teachers were also committed to developing teaching and learning for the benefit of their students and communities.</td>
</tr>
</tbody>
</table>

Teachers’ reflection on the lesson

We improved and developed our understanding of the process for teaching and learning, with activities that emphasise student participation and interaction with learning activities through a variety of practices. These include analysis, brainstorming and exchanging ideas between different groups; communication and presentation; gallery walks; using the jigsaw technique; fishbowl activities; and sales competitions, which enable our students to learn and understand the about wave breaks efficiently and produce their products effectively.

- Ms Suwaida Lahama, Ms Mareeyoh Saemahsae, Ms Isara Narawong, Ms Rosakimi Hayee-arong & Ms Aswanee Mathawee
Improper waste management is a persistent problem in many communities where there does not exist reliable and consistent waste collection systems. Trash pollution can cause a host of problems, polluting waterways, soil and even the air, when people resort to burning their trash. In Kampong Ayer, Brunei, waste management remains a problem as trash collection is irregular and infrequent. To combat the problem of pollution caused by improper waste management, Hj Muhamad Zuwaini Hj Aliyani (Mr Juen) and three of his high school students entered multiple competitions to finetune their mobile application as a waste collection solution. The project *Rubbish on Demand* facilitates a waste collection service that aims to both reduce environmental pollution and provide additional income for waste collection employees. In this chapter, Mr Juen shares his experience guiding his students in coding the app, and teaching them to think critically about doing their part for environmental and economic sustainability in their communities.

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### 3.4 Rubbish On Demand: Coding for waste management in Brunei

Hj Muhamad Zuwaini Hj Aliyani

Improper waste management is a persistent problem in many communities where there does not exist reliable and consistent waste collection systems. Trash pollution can cause a host of problems, polluting waterways, soil and even the air, when people resort to burning their trash. In Kampong Ayer, Brunei, waste management remains a problem as trash collection is irregular and infrequent. To combat the problem of pollution caused by improper waste management, Hj Muhamad Zuwaini Hj Aliyani (Mr Juen) and three of his high school students entered multiple competitions to finetune their mobile application as a waste collection solution. The project *Rubbish on Demand* facilitates a waste collection service that aims to both reduce environmental pollution and provide additional income for waste collection employees. In this chapter, Mr Juen shares his experience guiding his students in coding the app, and teaching them to think critically about doing their part for environmental and economic sustainability in their communities.

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### The importance of waste management in Kampong Ayer, Brunei

Kampong Ayer, translated as “Water Village” in English, is Southeast Asia’s largest water settlement, found in Bandar Seri Begawan, Brunei. These traditional villages are built entirely on stilts, housing more than 10,000 Bruneians.¹ A cultural treasure, visitors can explore floating markets and local handicrafts made by locals.² Located along the Brunei River, there has been a perennial issue of water pollution and improper waste management plaguing Kampong Ayer.
Over the decades, the scenic beauty of the village has slowly deteriorated due to trash buildup. Without a robust waste management system, rubbish often accumulates on the riverbanks of the Brunei River and underneath the Kampong Ayer’s stilt houses. In 2018, more than 20,000 bags of rubbish were collected from the river in just two months alone.

In Brunei, waste management is typically handled by private companies that collect waste from all locations. The frequency of waste collection spans from every few days, to sometimes only once a week. Particularly during events or gatherings, households and establishments accumulate large amounts of waste including food waste, that require prompt collection. However, due to irregular waste collection schedules, the accumulated waste is often left uncollected for many days resulting in mass waste buildup and overflowing rubbish bins.

Due to the irregularity and frequency of waste collection, unlawful practices of indiscriminate dumping are rampant in Brunei, where roads, coastal areas and sewages have become illegal dumping grounds. A person living in Brunei produces 1.14 kilogrammes of waste every day, according to 2019 statistics, making Brunei the biggest waste generator per capita in Southeast Asia.

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Ways improper waste management lead to pollution in Brunei

**LAND POLLUTION**
Stray cats, dogs and monkeys searching for food from trash bins causes land pollution

**AIR POLLUTION**
Some people burn their trash rather than disposing them into the proper disposal area, polluting the air

**WATER POLLUTION**
In Kampong Ayer, garbage disposal is inappropriately done via the river due to the lack of proximity to proper rubbish disposal areas

**REASONS FOR POLLUTION IN KAMPONG AYER DUE TO WASTE IMPROPER MANAGEMENT**

1. **Limited waste collection infrastructure**
The water village’s unique setting makes waste collection infrastructure difficult to establish. Narrow walkways and limited road access can impede the regular collection of waste, resulting in accumulated rubbish.

2. **Improper waste disposal practices**
Some residents may engage in improper waste disposal practices out of convenience, such as dumping rubbish directly into the waterways or indiscriminate littering. This contributes to water pollution, negatively impacting the environment and aquatic life.

3. **Insufficient waste segregation**
Inadequate waste segregation practices can hinder recycling efforts. Without proper separation of recyclable materials, a significant amount of waste that could be recycled ends up in landfills.

4. **Over-crowding of rubbish bins**
There are rubbish bins along the walkways in Kampong Ayer. However, trash accumulates when waste collection is not frequent enough, and the bins get raided by wildlife, resulting in more trash falling into the river.

5. **Debris from accidents pollute waterways**
Waste is sometimes generated from accidents, such as burning houses, which results in floating wood and other debris clogging up the river.
To address improper waste management in Kampong Ayer, Mr Juen and three of his secondary school students entered the 2019 Asia Pacific ICT Alliance (APICTA) competition, creating the application Rubbish on Demand (ROD) as a solution to the issue. Brainstorming ways to combat land, water and air pollution in Kampong Ayer, Mr Juen and his students created ROD as a mobile waste collection and management service, tackling the predominant cause of pollution: improper waste management.

**A brief background on coding**

A part of STEM education, coding has become a highly-valued skill in the 21st century. As computers do not communicate the same way humans do, code language is the translator for humans to programme commands in computers.

A code converts human input and intent into numerical sequences that computers can understand. Different coding programmes can be understood as languages that convert human instructions processible to computers, directing them to carry out specific tasks.

The process of writing a code is outlined as such:

1. Establishing a task that the coder wants the computer to perform
2. Translating instructions into a code, using a coding language, termed a “command”
3. Testing and revising the code, which instructs the computer to carry out the task

**Example of a code:**

In Python coding language, the code `print "....."` instructs the following sentence to be displayed onto the computer screen, e.g., the command `print "Hello, world!"` outputs the phrase “Hello, world!” onto the computer display.

---


Coding can be differentiated into **block-based** and **text-based** coding.

**TEXT-BASED**

Lines of code are written in syntaxes and stored as text files used to build computer programmes.

Recommended for experienced coders, as coding language may feel foreign to beginners.

Examples of such programmes include: Python, Java, CSS/HTML and Javascript

---

**BLOCK-BASED**

Text-based commands are consolidated into pre-programmed blocks dragged and dropped to create computer programmes.

Recommended for beginners and children, coding is easier to learn using this visually based programme.

Examples of such programmes include: Scratch, App Inventor, Snap!

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BEGINNER RESOURCES FOR CODING

<table>
<thead>
<tr>
<th>Elementary school</th>
<th>Middle school</th>
<th>High school</th>
</tr>
</thead>
</table>

Text-based coding and block-based coding

Image source: CodeREV

When using MIT’s *App Inventor* to create the ROD app, Mr Juen and his students used the block coding technique to design the app.
MIT’s App Inventor

To create his award-winning ROD app, Mr Juen’s students learned block-based coding to create their application using MIT’s App Inventor. MIT’s App Inventor is an intuitive, visual coding programme that has been made easy for coding beginners to learn. The simple drag-and-drop blocks are designed such that even high-level, complex applications can be created.

Did you know

Mr Juen and his students are self-taught coders. Because of the success of Rubbish on Demand, the Bruneian Ministry of Education made coding a compulsory module in every school.

Some of the main components which were used for ROD include:

1. Buttons

Buttons are one of App Inventor’s most fundamental components. It performs different core functions when used. For example, the user here has input a map as part of the user interface using the button “Map”. After inputting a geographical map, the user clicks on the button “Marker” to drop pins on specific locations on the map.

Similarly, Mr Juen’s students have used these buttons to outline dumping sites in the different districts of Brunei.

2. Blocks

Blocks are built-in pre-programmed instructions that specify how components behave when interacting with a user. These blocks are categorised to perform different designated functions and can be combined to create more complex functions.

For example, green “event handler” blocks are paired with purple “command” blocks to programme how a phone should react in response to different actions by the user.

When someone clicks on a button or shakes the phone, the application is programmed to play a sound. The phone is also programmed to vibrate for 500 milliseconds in response to the user clicking on a button.

The MIT App Inventor was thus used to create ROD during the pilot phase of the project. Helping to develop the initial version of ROD, it was also crucial to the improvement of the second version of Rubbish on Demand, ROD 2.0, which eventually won the 2019 APICTA Awards.

Solving environmental pollution through a waste-collection app

This project is a hands-on solution to solving pressing environmental challenges in the Kampong Ayer community, while connecting key knowledge and competencies in geography, mathematics and entrepreneurship.

In Brunei, the school syllabus has not yet included classes on ICT advancements and basic coding skills in the syllabus. As his students then have no prior knowledge of coding, Mr Juen started this project to let his students experience working directly with technology and learn key coding skills through creating the app on their own. Through creating the app, students also considered their own business plan to ensure the longevity of their waste-collection initiative.

Desired learning outcomes and lesson objectives

The main topics covered in this project are:

- Types of environmental pollution caused by improper waste management
- Coding and programming skills
- Entrepreneurship

---

**KNOWLEDGE AND SKILLS**
From creating the app, students will be able to gain the following knowledge and skills:

<table>
<thead>
<tr>
<th>Knowledge and skills</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students understand the problems with improper waste disposal, waste collection systems, and environmental management in their locality.</td>
<td>In order to solve the environmental problems found in Brunei, students need to develop higher-order evaluative skills.</td>
</tr>
<tr>
<td>Students make use of higher-order thinking skills to create an app that solves the problem of improper waste disposal, through creating a business-oriented waste-collection app.</td>
<td></td>
</tr>
<tr>
<td>Students master basic coding skills and use them to create an app.</td>
<td></td>
</tr>
</tbody>
</table>

**VALUES**
Through the lesson, students will cultivate the following values:

<table>
<thead>
<tr>
<th>Values</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMMUNITY-RESPONSIVE</td>
<td>Students will be able to appreciate the role they can play in thinking of and contributing solutions to help reduce pollution problems in the community.</td>
</tr>
<tr>
<td>ENTREPRENEURIAL</td>
<td>This app can create job opportunities which can provide part-time or full-time employment for the local community.</td>
</tr>
</tbody>
</table>

**IDENTIFYING THE PROBLEM: POLLUTION FROM WASTE**
Students were first tasked to identify environmental problems faced in Brunei, and then to devise a solution that can mitigate these problems. Mr Juen and his students brainstormed environmental challenges in Brunei through conducting extensive research, and thinking of challenges where ICT application can be a meaningful solution.
Initially, students aimed to reduce water pollution in the river but later, expanded their scope to creating solutions for land and air pollution as well, and homed in on Kampong Ayer as the location to tackle the three types of pollution caused by improper waste disposal.

After conducting intensive research on waste management and waste collection companies in Brunei, the students identified that **improper waste disposal** and **infrequent waste collection** were the two main factors contributing to land, air, and water pollution in Kampong Ayer. They then set out devising a solution to solve environmental pollution from improper waste management.

**Devising the solution through ICT: an app to facilitate waste collection**

As a solution to the problem of improper waste disposal in Kampong Ayer, the students decided to create a mobile application that acts as an **online waste collection system** to make waste collection more frequent and efficient for the inhabitants of Kampong Ayer.

The app will effectively address the problem of timely rubbish collection, particularly in residential areas. By facilitating prompt rubbish pickup, it significantly reduces the accumulation of waste and prevents it from being scattered further by animals or other factors. This helps maintain cleanliness and prevents littering, contributing to a cleaner and more hygienic environment.

In their ideation, the students identified that the app will have two types of user profiles:

1. The **customer**
2. The **Green Hero** (trash collectors)

Both the customer and trash collector are required to register their profiles on the app through filling out a form. They would go through the following steps to match customers requiring trash collection services to trash collectors who get paid a fee to collect the trash:

**Customer**

- After completing the registration process, customers can sign in using their ID.
- They can then select the type of rubbish they want to be collected, such as paper, glass, plastics, mixed waste, or other categories.
- Customers can take a picture of the rubbish to provide visual documentation.
- They are also required to enter the exact location and share it through the app before submitting their request.

**Green Hero**

- Once a customer submits their request via the app, a notification will be sent to the green hero’s app.
- The green hero will proceed to the designated area to collect the rubbish and accept payment from the customer, either in cash or via online methods.
- Upon collecting the rubbish, the green hero will scan a QR code at the rubbish dumping area to ensure proper disposal.
- The app will display a map showing the destination or route for the green hero’s collection activities.
APPLYING UX DESIGN TO CREATE AN APP

Mr Juen met with his students once a week to guide them in the development of a mobile application to facilitate waste collection in Brunei.

When designing the ROD app, the students had to keep the end user in mind to ensure the design was easy to use, and the language used in the app was easily understood. These were important considerations as the app was meant for two specific groups of people who would most likely make use of the app’s services:

1. Busy working adults
2. Elderly folk

In addition, ROD was created with the hope of providing meaningful employment to fresh graduates and those looking for part-time employment.

Keeping this in mind, the students had to consider user experience (UX) design. This included thinking about:

1. **Language used in the app**
2. **Registration process for both customers and Green Heroes**
3. **Account verification process**
4. **Live location tracking of:**
   - Green Heroes
   - Rubbish dumping areas
5. **Features for customer use such as:**
   - A satisfaction and feedback system
   - Customer support

They also had to incorporate a back-end system that provided information on the following:

- Human resource management related to:
  - Applications for Green Heroes positions
  - Green Heroes credit management
- Live updating of the total numbers of Green Heroes, customers, transactions, and current jobs
- Help desk queries

**KEYWORD**

*User experience (UX) design* is a human-centric way of designing products that ensure users have a smooth and pleasant experience all from their first product interaction to the end. The ultimate purpose of UX design is to create easy, efficient, relevant, and all-around pleasant experiences for the user.

The five key principles of UX design are:

1. **Hierarchy:** Visual and information organisation
2. **Consistency:** Similar functions and visual cues across commonly-used apps or products
3. **Confirmation:** Require confirmation for any important or irreversible action to prevent errors, e.g., making payment, deleting items
4. **User control:** Designing to recover from errors, e.g., an undo button, and improving user efficiency, e.g., keyboard shortcuts
5. **Accessibility:** Designing for inclusivity, for multimedia, designing considering users with disability.

Language used in the app
Registration process for both customers and Green Heroes
Account verification process
Live location tracking of:
- Green Heroes
- Rubbish dumping areas
Features for customer use such as:
- A satisfaction and feedback system
- Customer support
Designing and coding the app
To design the app, Mr Juen took his students through the following steps:

1. SKETCH THE INTERFACE
The students were first instructed to first design the layout of the app on paper. To reduce the complexity of the app, the design of the layout was confined to fewer than 10 pages in-app. This step was critical in ensuring that the process of designing the app would be organised and well thought-out, and that the end product would be user-friendly.

2. STRUCTURE AND NAVIGATION
Students were guided to organise the app interface in a structured manner, ensuring clear links between pages and a logical flow of information. Students checked to ensure the links adhered to UX principles, so the app interface remains user-centric.

3. FUNCTIONAL BUTTONS
In this step, students programme the app and ensured all buttons and interactive elements in the app are functional and perform their intended functions correctly.

After designing the app on paper and mapping out the critical features it should contain, Mr Juen taught his students how to use MIT App Inventor, a programme that assists the creation of apps. He had his students familiarise themselves with the core functions of each component in MIT App Inventor to create their app-based solution. He went through these steps:

• Get students familiar with the core functions of each app component in App Inventor, and in their own app design.
• Guide students on how to interact with programme blocks to specify how the components should behave in their app.
• Whenever students drag and assemble their block, they should test it out with their mobile devices or web emulator to ensure the component is functioning as planned.
• Utilise YouTube resources to guide students on the programme's different functions

KEYWORD
An emulator is a type of programme that lets you run software from a different device on your computer. For example, Mac emulators can be installed on a Windows PC to run the Mac operating system.

For this project, Mr Juen and his students installed an Android emulator on their computers so they can easily test their app prototypes using the onscreen Android emulator without having to constantly download multiple app versions into their phones.

Features of the ROD app, including selection of trash type, photographing the trash to be collected, and setting current location
4. ENVIRONMENTAL REPRESENTATION
When designing the app, students used colours like green and blue to represent an environmentally-friendly brand in-line with their mission.

5. TESTING THE APP
After the app design has been finalised, students run the full version of the app on different devices and operating systems to check for bugs, glitches, or usability issues.

RUBBISH ON DEMAND’S BUSINESS PLAN
To ensure the waste collection service remained a sustainable practice for both Green Heroes and customers, Mr Juen and his students devised a business plan to estimate how much revenue the app could generate for the waste collectors, while keeping rubbish off the streets.

From the following potential revenue streams:
- Waste disposal fees from a projected 47 houses per day using Rubbish On Demand’s services
- Subscription fees from about 190 potential Green Heroes
- Share of revenue generated by Green Heroes
- Partners such as recycling and fertiliser companies

The annual revenue from the business could be more than $20,000, with an estimated profit of about $14,000 after five years of operation.
GAINING REGIONAL RECOGNITION IN APICTA 2019

The journey to entering and winning the Merit Award at the APICTA 2019 awards was a long but fruitful one. Mr Juen and his three students first entered a Hackathon organised by the STEP Centre Brunei. This process involved going through a three-day workshop where participants focused on addressing environmental concerns in the country, and was where the team picked up skills to use MIT App Inventor. The first prototype proposal of ROD was born here, initially called BruClean.

After winning the Hackathon, the team was invited to participate in the national Brunei ICT Awards (BICTA) competition. This involved the team conducting extensive research and attending the three-month BICTA Bootcamp in town. During this competition, the team learnt about developing business pitches to gain interest from investors, refine their app pitch as a sustainable waste management solution, and refine the interface for the app.

After gaining much experience and knowledge in refining their mobile application solution to waste management in Brunei, and honing their pitching skills, Mr Juen and his team prepared to enter ROD in the 2019 international APICTA awards held in Ha Long Bay, Vietnam. Mr Juen helped his students extensively prepare for the competition by practicing their pitches whenever they can, and refining their scripts. At this point, they had refined ROD to be a user-friendly, sustainable solution to the problem of waste management in Brunei, and were excited to be the first Arabic school to represent Brunei in an international competition.

REFLECTION

Even after winning the Merit Award at the APICTA 2019 awards, students were asked to reflect on how the app could be effective in reducing pollution and at the same time creating jobs for the community.

They had to consider the role of Brunei’s Department of Environment, Parks and Recreation (JASTRe), and the relevance of connecting the community with the Department’s functions.

Without the close cooperation of the local community with local government agencies, it is difficult for the app to see its full potential. Mr Juen asked his students these guiding questions:

1. Reflect on the strengths and weaknesses of the app. What aspects were successful, and what can be improved upon?
2. Reflect on the feedback received from the competition judges and their mentors. How can they use this feedback to improve?

SCAN TO LEARN more about Rubbish on Demand via their social media pages!
The idea of developing an app in lessons could help teachers and students, specifically in Brunei Darussalam, to improve their quality of work and education and simultaneously sustain a future-ready economy that freely utilises and relies on technology. In order to achieve the Brunei Vision 2035, education should be the first step to realising a knowledge-based economy. This project can become an early investment for the students, as it opens them up to a relatively new field and enhances their cognitive skills and critical thinking skills for better results and a bright future.

In the near future, this app can be a platform towards developing national education and can be further developed into a marketable product. This product will not only be sold locally, but can also be used internationally.

Since the lesson is time consuming, extra time is needed for the teacher to deliver the knowledge to the students and accompany them while working.

Mr Juen brought his students into town to meet mentors, such as Pengiran Sarimah Pg Latiff Abbas, Chairwoman of InfoCom Federation Brunei. They advised students on overcoming real challenges, and gain knowledge on making their solution applicable for the real world.

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Mr Juen spent extra time with his students during his Extra-Curricular Activities time to discuss how they can improve the app. Spending three months in the BICTA bootcamp also honed the students’ app-creation skills and gave them ample resources.

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I hope that you have found The HEAD Foundation’s sixth Making HEADway handbook, *Becoming Leaders in Sustainability Education*, helpful. I am certain that many of you have received and used previous handbooks and might have noticed this is different — an evolution of previous series.

Last year, to better understand the impact of the Making HEADway ecosystem of resources, The HEAD Foundation commissioned an independent impact assessment. I would like to take this opportunity to thank those of you who took the time to participate and contribute to the assessment. The results of the assessment were heartening for my amazing colleagues. We were pleased to see how our humble project, conceived during the darkest days of the COVID-19 pandemic, evolved to an impactful teaching and learning tool for educators across Southeast Asia and beyond. Beyond the kind words, the impact assessment also provided us actionable tips and suggestions to improve the Making HEADway ecosystem, particularly the handbooks.

Starting with this series, the handbook will become the core resource and initial output for each new series. In addition to actionable tips and suggestions, it will now feature detailed unit and lesson plans. This enhancement aims to facilitate the adaptation and implementation of the materials in your classrooms, as many of you have expressed the desire to share this knowledge with your learning communities.

So why title this soft relaunch of the Making HEADway series “Becoming Leaders in Sustainability Education”? We want to empower educators like you to understand that for sustainable practices to truly take root, it must be tightly integrated into the curriculum and demonstrate its long-term benefits to students and parents. We hope the stories and lessons in this book show you that every teacher is a leader, and every small action can add up to create a huge impact.

In this handbook, and throughout the series, we go beyond simply promoting sustainable practices. We show you how to incorporate sustainability education into your existing curriculum. We will demonstrate how you can leverage this crucial topic as a platform to teach students essential skills that will transform them into proactive, global-minded individuals who can effect real change. By integrating sustainability into the fabric of education, we can cultivate a generation of students who understand the importance of sustainable living and sustainable growth, and equip them with the skills they need to shape this crucial century for the better.

We hope that this handbook inspires you to explore the suggestions and utilise the unit and lesson plans in your own practice. We value your feedback and encourage you to share your experiences with us. Please don’t hesitate to reach out to us at headway@headfoundation.org with your thoughts and suggestions.

Thank you for your dedication to education and for being a part of the Making HEADway community.

Yours sincerely,

**Vignesh Louis Naidu**
Director, Operations
The HEAD Foundation
Making HEADway

was conceived, designed and launched by The HEAD Foundation in 2020 in response to the COVID-19 crisis. This expanding suite of teacher professional development tools include (1) Practitioner-focused handbooks for educators, (2) Small-group hands-on workshops, and (3) Webinars and lectures, all focused on building up teacher capacity and communities of practice amongst Southeast Asian educators.

ENHANCING REMOTE LEARNING

Building upon the tools and techniques covered in previous series, this issue dives deeper into the challenges of remote learning, and how educators can capitalise on the opportunities for change to deliver effective learning to students regardless of modality. We explore online and offline learning tools and efficient assessment methods that can be translated into classrooms even as in-person learning resumes.

BRIDGING THE GAPS IN REMOTE LEARNING

Much has been said about the educational inequalities exacerbated by the COVID-19 pandemic — but what can be done to alleviate the situation? We explore the spectrum of educational technologies from virtual classrooms to radio lessons, show how communities play a part in education, and how we can create inclusive and engaging lessons in a remote setting.

TEACHING STEM IN SOUTHEAST ASIA

The strength of an interdisciplinary STEM education lies in its ability to tie concepts from differing disciplines together to form creative synergies, and through the process of problem-based learning, encourage in students the traits of ingenuity, teamwork and resilience. This handbook looks at some of the tangible and tried ways educators in the region have made use of STEM concepts and theories to bring STEM lessons to life, even as remote and hybrid learning remain a long-term reality for many.
The Sustainability Learning Lab (SLL) aims to be the leading international centre for sustainability education by promoting the translation and scalability of sustainability and sustainability education outputs.

A sustainability research- and outreach-focused centre within National Institute of Education, an institute of Nanyang Technological University, Singapore (NIE NTU, Singapore), SLL seeks to grow expertise in sustainability research and education.

Through leveraging NIE’s research on sustainability and sustainability education, SLL provides evidence-based curriculum resources and pedagogy to support sustainability and environmental education at all levels. Focusing on three main aspects, the SLL encompasses:

(i) Knowledge construction through sustainability and sustainability education research

(ii) Translation of sustainability and sustainability education research into curricular and pedagogical resources

(iii) Outreach to stakeholders in developing a community of practice to share and advance the work in knowledge and translation of sustainability and sustainability research

The centre actively collaborates with key stakeholders in education and research institutions, government agencies, and non-governmental organisations on sustainability and sustainability issues. Through its research-informed programmes and courses focused on the sustainability values and dispositions needed for a future-ready citizenry, SLL leads in defining the sustainability education research agenda for Singapore and beyond.
Impacting lives in Asia through quality education and effective healthcare

The HEAD Foundation is a charitable organisation set up in 2013 in Singapore to contribute to sustainable development in Asia.

headfoundation.org