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The Intended, Enacted and Experienced Curriculum: Realising Sustainability Education through Singapore Secondary Geography

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Abstract

This paper examines the strengths and constraints of the Singapore Secondary Geography curriculum in advancing sustainability education and suggests that current approaches to sustainability can lead to simplified representations of climate solutions, limited engagement with social and ethical trade-offs, and insufficient attention to unequal impacts across places and communities, even within student-centred classroom contexts.Drawing on lesson examples, learning artefacts and student reflections, this paper illustrates how teacher curriculum-making enables the enacted curriculum to complement the intended curriculum in equipping students to think through systems, recognise contested sustainability pathways, and act as informed stewards of their environment. Through intentional task design, scaffolded inquiry and reflective dialogue, classroom enactment moves learning beyond discrete topics towards understanding the consequences and feedback loops across human and environmental systems. Sustainability is therefore approached not as arriving at a set of correct answers, but as exercising judgment through ethical reasoning and careful considerations of trade-offs.

Introduction

Sustainability education is increasingly emphasised as a key driver for sustainable development (Becker, 2018; Boström et al., 2018). Moving beyond traditional environmental education, which focuses on raising awareness of ecological challenges, sustainability education inculcates in learners the knowledge, skills, attitudes and values required to take individual and collective action in addressing present and future environmental, economic and social challenges. (Elegbede et al., 2023) Geography is particularly well placed to advance sustainability education. As an integrating discipline that spans the sciences, social sciences and humanities, it encourages learners to think critically about the nuances and complexities of human-nature interactions, to recognise the inequalities that impact the wellbeing of people and the planet, and to reflect on their agency in shaping a sustainable future. The Singapore Secondary Geography syllabus foregrounds themes of sustainable development, introducing topics on sustainable resource use and management in the Lower Secondary curriculum, with further exploration of human-environment relationships and sustainability challenges in the Upper Secondary curriculum (Ministry of Education, 2023). This reflects a deliberate progression to deepen learners' use of disciplinary lenses in critically engaging with sustainability. However, the extent to which it promotes sustainability education in terms of building empathy and transforming behaviour needs more careful examination. This paper examines the strengths and limitations of the Singapore Secondary Geography curriculum in supporting sustainability education and proposes possible approaches to strengthening its capacity to nurture not only cognitive understanding, but also the socio-emotional dispositions and behavioural changes that will enable learners to contribute to environmentally sound, economically viable and socially inclusive futures.

Curriculum Enablers and Constraints for Sustainability Education in Geography

Geography as an Integrative Discipline for Sustainability Education

A key strength of the Geography curriculum lies in its intentionality in connecting natural and human systems across the topics explored. This allows learners to recognise the interdependence between humans and the physical environment, in that humans extract resources from the physical environment, while physical environments are sustained and increasingly shaped by anthropogenic activities. This framing is crucial for sustainability education, which requires learners to grasp the ecological, economic and social implications of human-nature interactions. The *Geography in Everyday Life* Cluster (Upper Secondary Geography)(Ministry of Education, 2023) illustrates this interconnectedness clearly. Learners explore the ecosystem services nature provides for humans, while examining how some human actions–through urbanisation, pollution and resource extraction–can degrade the physical environment. This enables learners to make connections between theory and their lived experiences. For a highly-urbanised and resource-scarce country like Singapore, the inclusion of this topic helps make sustainability issues locally relevant.

While the interdisciplinary nature of Geography provides a strong foundation for sustainability education, the way interconnectedness is represented shapes the type of sustainability consciousness that learners develop. In practice, this interconnectedness often carries a utilitarian slant, framing the environment primarily in terms of the resources and services it provides for human use, rather than as a system with intrinsic value and hence something worth safeguarding. This appears to align with pragmatic state narratives, where resource efficiency and the survival of our small island state is often espoused, with responses to environmental issues often framed in terms of initiatives that generate material value or advance the country's economic competitiveness (Han, 2017). In the case of climate action, this translates into investing in low carbon technologies, exploring alternative energy imports or redesigning infrastructure to adapt to sea-level rise. Mentions of the role of individual action in the curriculum, such as making more sustainable consumption choices, are comparatively scant. While it is true that individual action is limited in addressing systemic challenges that require significant infrastructural and geopolitical transformation, neglecting the dimensions of ethical responsibility and empathy may mean confining the curriculum's capacity to nurture a deeper ecological consciousness, one that encourages learners to see themselves as embedded within, rather than separate from, the natural world. (Heikkinen et al., 2024). Without this deeper mindset shift, sustainability education risks producing technically competent learners who may be able to calculate the costs and benefits of human actions but with limited sense of responsibility or stewardship. Consideration may therefore extend unevenly, leaving both non-human life and communities who bear the disproportionate burdens of sustainability transitions at the margins.

Representations of Sustainability Challenges

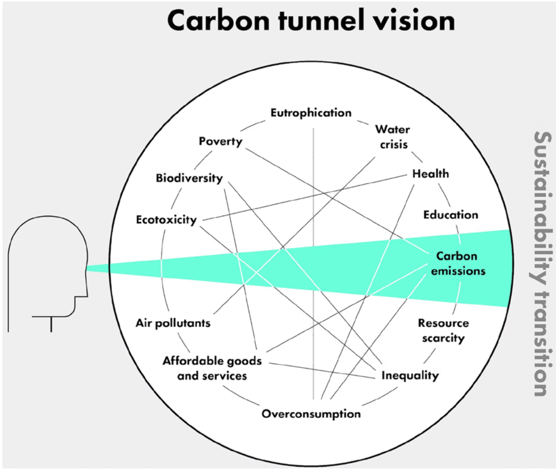
The Secondary Geography syllabus also introduces learners to contemporary issues such as sustainable urban planning, water management and renewable energy, ensuring that learners are exposed to globally relevant debates (Ministry of Education, 2021, pp. 16–17). This provides opportunities for learners to unpack and apply disciplinary concepts in addressing current and future-oriented challenges. However, when it comes to prompting learners to reflect more deeply on the impacts of human action or inaction, the way these topics are represented often stops short of cultivating the type of critical thinking that sustainability education demands of learners. The treatment of climate mitigation strategies provides a case in point.

While learners are prompted to consider the benefits and limitations of various low-carbon technologies and clean energy sources, the ideas tend to be presented in an overly-simplistic and decontextualised manner. Solar, hydroelectric, geothermal and nuclear energy are broadly examined in terms of their technical feasibility and energy efficiency, without significant exploration of the wider systemic impacts on the natural systems. For instance, while solar energy is often hailed as a clean alternative to fossil fuels, there is no mention of the environmental costs associated with the mining of rare transition minerals to produce photovoltaic cells (Global Witness, 2024) or the waste management challenges societies will face at the end of the photovoltaic panels' life cycle (Xia, Yang & Poon, 2025). In the context of hydropower, the harms associated with dam construction are also not explored, including the trapping of nutrient-rich sediments upstream which reduces downstream productivity and contributes to declining fish catches (Chen, Shi & Huisman et al., 2020). This issue is particularly salient in the Mekong River basin, where the river's transboundary nature means that extensive coordination among multiple countries is required to ensure that renewable energy deployment does not undermine long-term economic and environmental sustainability. This is compounded by the power asymmetry in the region, with China's upstream position and greater infrastructural and political influence giving the country more leverage over downstream outcomes.

Little attention is also given to the social repercussions of sustainability decisions, particularly the unequal distribution of benefits and burdens across different spaces and scales. While the transition to a low-carbon future brings global benefits, it poses significant risks for workers in fossil-fuel-dependent economies. The International Energy Agency (IEA) reported that the coal supply industry saw approximately 225,000 job losses between 2019 and 2022, with coal miners bearing the brunt of the transition (IEA, 2023). An additional 1.4 million jobs, primarily in Asian countries such as China and India, also remain vulnerable to displacement by 2030. In the same vein, the land-use impacts of large-scale energy and development projects often fall disproportionately on rural communities, while urban populations benefit from clean energy and economic gains. Within Southeast Asia, the ongoing development of Rempang Eco-City, a China-backed project to turn the Indonesian island into a solar manufacturing hub, threatens to displace 7,500 Indigenous inhabitants, many of whom belong to the Orang Darat tribe. Beyond the violent confrontations and surprise demolitions of their homes faced by the community as part of the project's land-clearing efforts (Eco-Business, 2024), these developments would result in the loss of cultural identity and source of livelihoods for the predominantly Malay fishing communities with deep ancestral ties to the land. (Channel News Asia, 2023). A just transition therefore cannot be achieved through changes in technology alone. It involves meaningful consultation with affected communities, retraining and reskilling opportunities that enable participation in emerging renewable-energy sectors, and, where livelihoods and cultural ties are irreversibly disrupted, appropriate compensation or reparative measures.

The narrow framing of the effectiveness of sustainable development strategies may mean that learners are not exposed to the hidden trade-offs and unintended consequences that climate solutions bring. As such, we risk reinforcing a *carbon tunnel vision*, where solutions are evaluated solely based on their ability to reduce carbon emissions while ignoring all other environmental and social dimensions (Konietzko, 2021)(Fig 1). By focusing predominantly on the technologies in isolation, we risk presenting only a partial picture - one that glorifies alternative energy without closer inspection of possible resource exploitation, economic dependencies or the geopolitical dynamics surrounding it. To strengthen sustainability education, it is therefore crucial to broaden the curriculum's frame to one that provides students with opportunities to engage with the conflict dimensions of sustainability decisions (Boström et al., 2018).

Fig 1. Carbon Tunnel Vision (Konietzko, 2021)

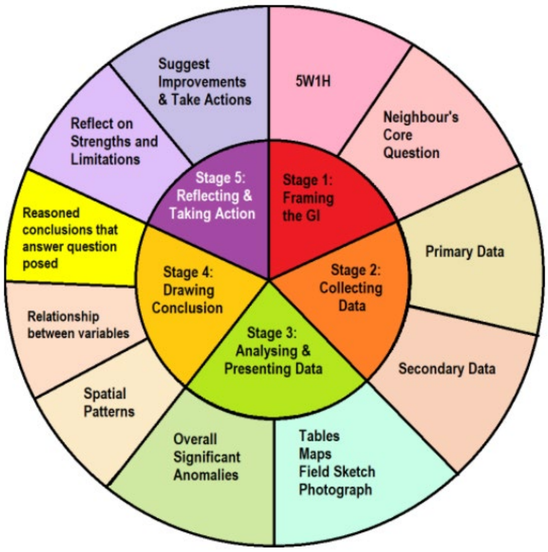


Fieldwork and Geographical Inquiry: Potential and Pitfalls

In both the Lower Secondary and Upper Secondary syllabus, students go through Geographical Investigations (GI), carrying out fieldwork following key stages of the inquiry cycle (Fig 2). They first come up with an inquiry question and decide on appropriate fieldwork methods before going into the field to gather data that will help them address their inquiry. They then analyse the data collected, with the GI culminating in the application of what they have learnt to evaluate their findings and draw conclusions. The inquiry framework provides a structured approach that allows students to engage with sustainability challenges through authentic inquiry. When framing the inquiry, students engage with real issues that affect people and places. When collecting data, they observe first-hand how human and natural systems interact in specific local contexts. When they analyse and interpret what they have gathered, the anomalies they grapple with will help them recognise that geographical phenomena are shaped by the uniqueness of place. This thus deepens their understanding of the geographical concept of place and helps them appreciate how different communities may experience environmental impacts differently.

Stage 5 of the Lower Secondary GI, which focuses on reflecting and taking action, is especially relevant to sustainability education. Beyond describing and explaining how their findings relate to broader sustainability challenges, it invites students to consider how different stakeholders, including individuals and communities, can respond to these challenges. Through this reflection, students will begin to see themselves as actors with a role to play in shaping a more sustainable future.

Fig 2. Stages of Geographical Investigation (Ministry of Education, 2021)



In theory, the GI process is designed to be student-directed, with learners taking ownership of the entire inquiry cycle and exploring the complexity of sustainability issues through repeated cycles of inquiry. In practice, however, the full potential of fieldwork in supporting sustainability education is not always realised. Teacher dispositions, confidence in facilitating open-ended inquiry and practical constraints such as limited curriculum time, logistical demands and assessment requirements can limit the extent to which GI functions as a genuinely student-led investigation (Chew, 2008). Seow, Chang and Irvine (2019) found that teachers often adopted a teacher-directed approach to inquiry, largely due to concerns about students' readiness for independent investigation. Consequently, they make most of the decisions about the scope, methods and parameters of the fieldwork, down to the selection of the fieldsite, leaving students mainly to follow instructions. Over time, this contributes to mere procedural enactments of GI, where teachers are positioned as providers of knowledge. This ultimately limits the authenticity of the experience and reduces students' sense of ownership over the inquiry process. While the 2023 Upper Secondary syllabus introduced bite-sized fieldwork, designed to be accessible through day-to-day classroom instruction (Ministry of Education, 2023) (Fig 3) to overcome practical challenges of limited curriculum time and logistical demands, this approach also comes with trade-offs. Such activities may be piecemeal in nature - the depth and complexity of inquiry that students can engage in may be limited, further constraining opportunities for student autonomy.

Fig 3. Bite-sized and extended fieldwork (Ministry of Education, 2023)

Bite-sized Fieldwork	Extended Fieldwork
Designed to be accessible through day-to-day classroom instruction.	Designed as an engaging learning experience for students to acquire a deep understanding of geographical phenomena or issues that they are passionate to investigate.
Fieldwork skills can be integrated into the teaching of each topic or cluster.	Geography in Everyday Life Cluster will be applied by students to carry out in-depth study of any content area featured in the neighbourhood contexts and/or the prescribed clusters.
Not necessary for teachers to create a full-length fieldwork experience for students.	Teachers can consider differentiating content, process and product according to their students' interests, readiness and learning profile when designing a school-based fieldwork.

Strengthening Sustainability Education in Geography

Reframing Curriculum Through Systems Thinking

To realise the potential of Geography education in building empathy and transforming behaviour, teachers can interpret the curriculum through the lens of systems thinking—making sense of the complexities of the world by examining the relationships and underlying structures governing it rather than seeing them in silos or a sum of its parts (Meadows, 2008). Curriculum-making can be a powerful lever for change: when introducing students to geographical phenomena, teachers can help them see how issues are situated within a larger context, and how our decisions as individuals, organisations or nations shape not only local but also regional and global outcomes.

This can be done through frameworks or teaching tools that help students look beyond what is on the surface when examining sustainability challenges and trace how impacts link to deeper structural and ideological roots. One such teaching tool is the *Inequalitree*. Created by Ayendri Perera-Riddell, the Inequalitree illustrates the daily impacts, structural enablers and deep-seated ideologies of a social issue. In building an Inequalitree, learners assess sources of information, synthesise diverse perspectives and understand causes and implications of societal issues (University of British Columbia, n.d.). Fig 4 and 5 introduce how the Inequalitree can be used to frame and synthesise insights from case studies related to sustainability issues, while Fig 6 presents the learning artefacts produced by Geography student-teachers in a workshop I conducted, when they were introduced to this teaching tool and used it to unpack the impacts, institutions and underlying narratives behind the damming of the Mekong River, among other regional energy projects.

Fig 4. Inequalitree framework (Credits: EnergyCoLab)

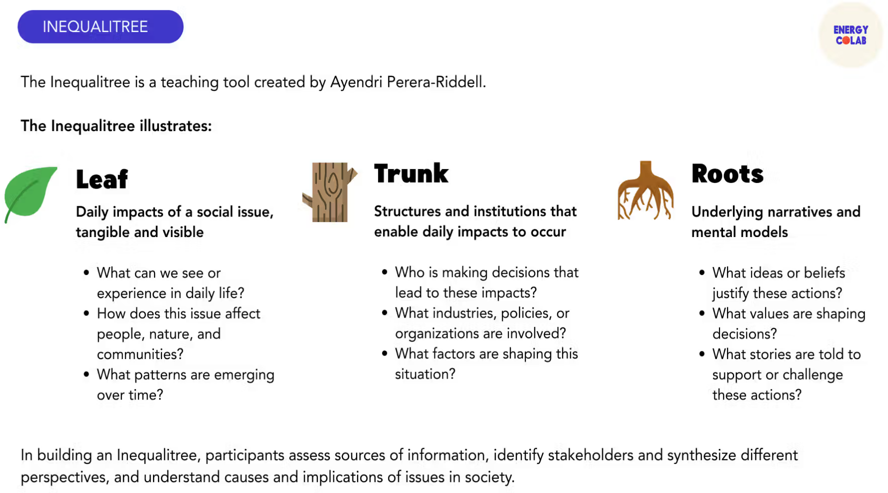


Fig 5. Application of the Inequalitree framework to synthesise insights from case studies (Credits: EnergyCoLab)

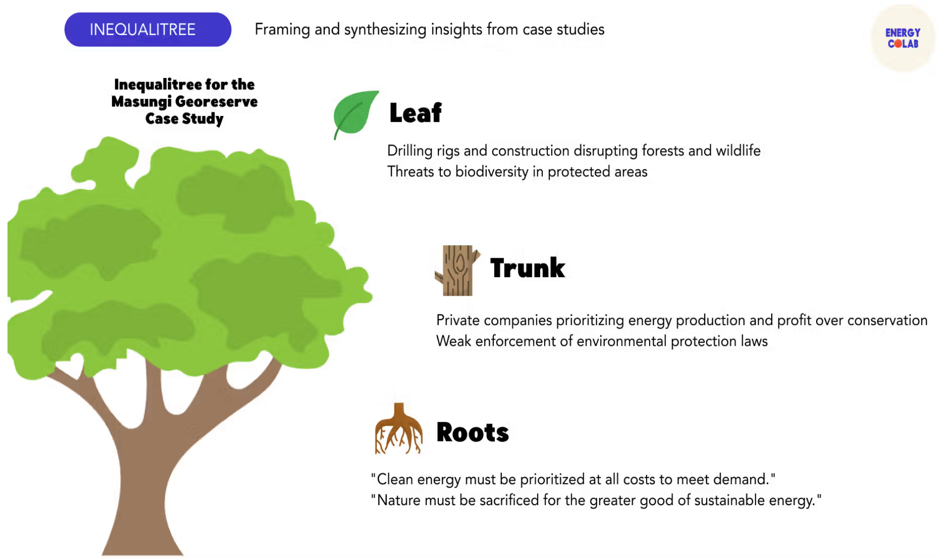
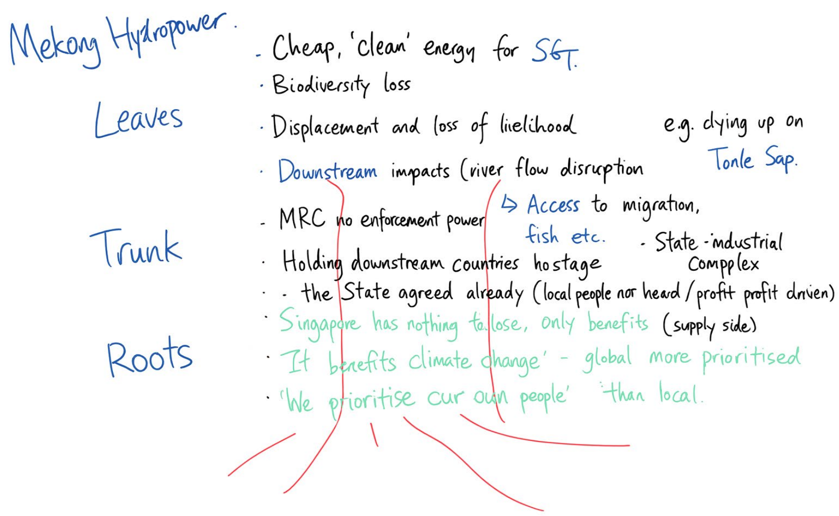


Fig. 6 Student-teachers' Inequalitree on the impacts and underlying drivers of Mekong hydropower development



In the context of sustainability education, learning experiences anchored by systems thinking encourage learners to question who gains and who loses in various sustainability pathways. In other words, it engages learners not only in terms of what solutions exist, but also how these solutions are contested across scales of society. This helps them recognise that the impacts from policy decisions invariably ripple across economic, environmental and social systems; that a corporation or nation's choice does only affect itself alone but also shapes regional and even international outcomes.

In the Inequalitree example above (Fig 6), learners came to the realisation that the way one country finances clean energy projects can shift environmental and social burdens onto neighbouring countries, and how the decision reflects a prioritisation of national interests over the common good while reinforcing existing power relations. This moves them beyond superficial evaluation of renewables from the economic or technical standpoint, prompting them to consider the deep institutional changes required for a sustainable future. This empowers them to ask critical questions and contributes to more informed and responsible decisions in their communities.

Game-based approaches, complemented by guided reflection, can also reinforce systems thinking and invite students to see sustainability issues as a complex and interconnected system, and themselves as a player that can influence outcomes. An example would be the Climate Fresk, a game that teaches players the fundamental science behind climate change and empowers them to take action (Climate Fresk, n.d.). Through collaborative game-based exploration, learners co-construct knowledge, unpack the cause-and-effect relationships behind climate change and reflect on the emotions raised before collaboratively identifying individual and collective solutions. Insights from my facilitation of the Climate Fresk workshop for young learners (aged 9-13) suggest that game-based learning not only connects the science to learners' head knowledge, but also to their emotions and sense of agency when it comes to climate action.

The workshop incorporated a reflective

exercise based on the head, heart and hands model (Orr, 1992). Learners articulated (a) the knowledge they gained (*Head*: What did you learn? What surprised you?), (b) their affective responses (*Heart*: How did it make you feel? What emotions surfaced?) and (c) their commitment (*Hands*: What small actions can you take, starting today?) Their responses demonstrated their appreciation of the interconnections within the climate systems and the reinforcing feedback loops.

> *One thing that I've learned today that I think is important is how one single thing leads to many many consequences. I think this is important because just turning on the aircon often will cause effects like global warming, melting of glaciers, floods and starvation.*

The learners also demonstrated their awareness of the unequal burdens of climate change and expressed their concrete commitments to behavioural change.

> *Homeless people will be the most affected by climate change. They do not have the [resources] to prepare for it, like a house to be safe in and food that are nutritious. This makes me feel sad.*

> *One thing that I will like to change in my life to help the Earth is to recycle more often and not buy things excessively. I will also encourage my family and friends [to do the same].*

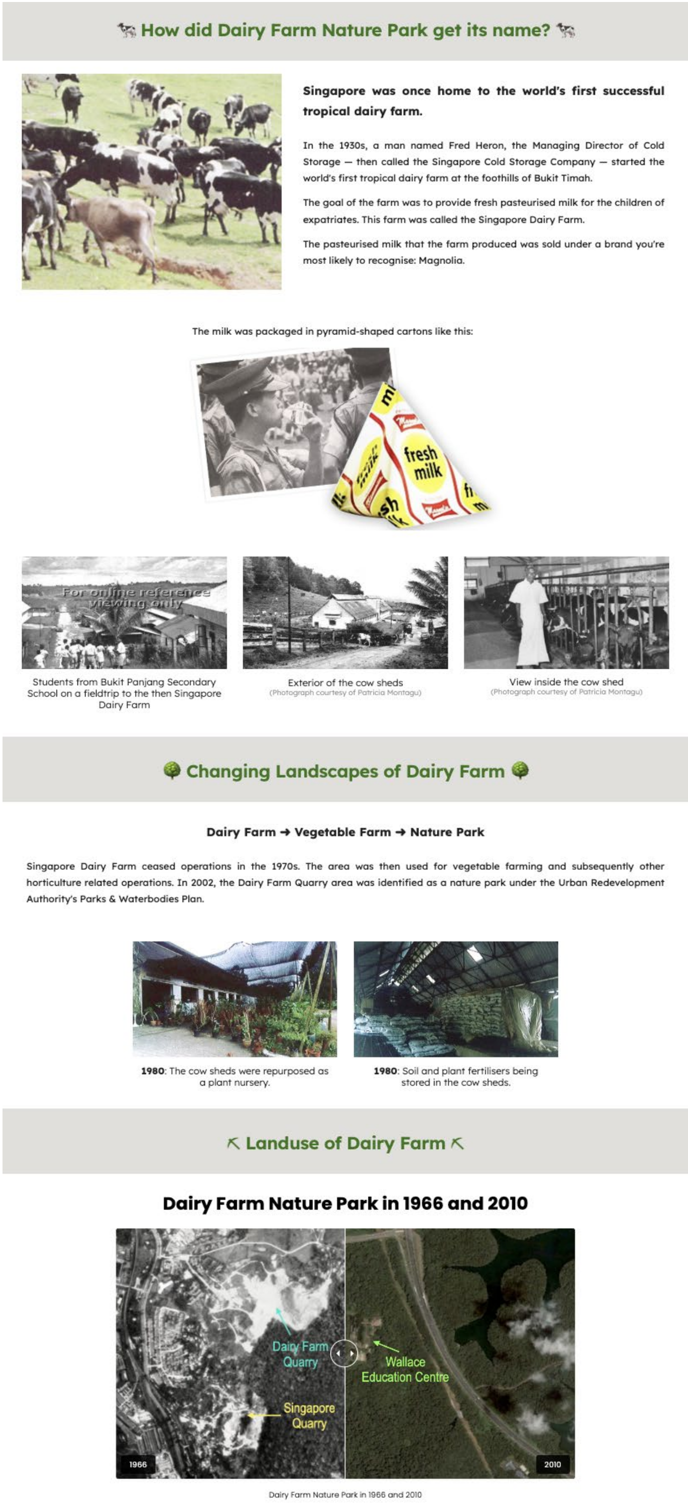
These responses illustrate how game-based learning, together with guided consolidation, can support students in connecting cognitive understanding, emotional engagement and a sense of agency, all of which are key dimensions of transformative sustainability education (Sipos, Battisti & Grimm, 2008).

Building Ownership and Agency Through Student-Directed Field-based Learning

As outlined earlier in the previous section, fieldwork—when designed with students as active inquiry learners in mind—can serve as a powerful vehicle for sustainability education by allowing students to explore sustainability issues within their context, examine human-nature relationships through direct observations and be involved in reflective decision-making. This potential is exemplified in the Secondary 1 GI that I designed and carried out as part of my teaching practice, where students formulated their own hypotheses about the impacts of human modification on the natural environment at Dairy Farm Nature Park, collected primary data, synthesised their findings and reflected on possible responses to sustainability concerns they observed.

Prior to the fieldwork, students were introduced to the history and evolution of the park, from its past function as a dairy farm and quarrying site that caused environmental degradation, to its current land use as a nature park following rehabilitation efforts (Fig 7). In groups, students then formed their own hypothesis to the inquiry question: "How do human activities affect our natural environment?". They predicted that environmental conditions such as temperature and noise levels would vary depending on the degree of human modification.

Fig 7. Teacher-created Google Site designed to situate students within the socio-ecological history of Dairy Farm Nature Park.



During the actual fieldwork, students gathered primary data, including temperature, wind speed and noise levels across multiple checkpoints with differing degrees of human modification. Given that these variables stemmed from students' own hypotheses, the data collection process empowered them as producers instead of consumers of knowledge. The data collected was represented visually with the use of heat maps and graphs, which complemented the observations and photographs students populated in a shared slide deck (Fig 8). Together, these sources of empirical data supported class discussions and enabled students to validate their initial hypotheses. Finally, students evaluated the strengths and limitations of the GI and proposed actions to reduce human impacts at the individual and community levels.

While the overarching inquiry question and the choice of fieldsite were predetermined by the teacher, students were able to exercise meaningful agency throughout the inquiry process. Because they had formulated their own hypothesis, they also determined what forms of data would be needed to test them. As a result, the photographs, field observations and weather tracker readings collected were not merely tasks assigned by the teacher, but student-led and student-generated data that directly served their inquiry. The process of synthesising these diverse data sources also required students to interpret evidence that they had gathered, rather than working with pre-selected secondary data provided by the teacher. For example, temperature readings collected helped them to verify whether areas with greater human modification in the nature park were indeed warmer, grounding their conclusions in data rather than relying on secondary information or subjective impressions. Overall, the GI design shifted students from passive observation to active, student-directed investigation, encouraging them to take ownership of the inquiry and reflect on their responsibilities as stewards of the environment.

Fig 8. Students' qualitative data collected at Dairy Farm Nature Park, accompanied by heat maps and graphs generated by the teacher based on student-collected data

Another example that showcases how fieldwork can promote student agency comes from a Secondary 2 GI I facilitated, where students examined real-life sustainability challenges and applied their understanding of environmental issues to design sustainable solutions. In the final stage of the investigation, students were tasked to design a neighbourhood that balances social inclusion, environmental quality and liveability. Crucially, they were given full autonomy over the platform used to create their prototype on—the prototype could be a physical model, a hand-drawn blueprint or one that is developed digitally. This approach shifted the GI from one that is teacher-directed to one that emphasised student agency and creativity. The result was a wide variety of prototypes that reflected students' interpretations of sustainable neighbourhoods (Fig 9). This task demonstrates how promoting student autonomy and not limiting their creativity can cultivate greater ownership over their learning, and evolve GI beyond procedural skill acquisition. It enables learners to develop awareness of community needs and environmental considerations when justifying their design decisions, helping them to become more thoughtful designers of a sustainable future.

Fig 9. Students' neighbourhood prototype artefacts

Conclusion

While the Singapore Secondary Geography curriculum provides a strong conceptual foundation for sustainability education given its interdisciplinary nature and focus on human-environment interactions, this potential is limited by its utilitarian framing of nature, coupled with narrow representations of sustainability strategies. Furthermore, the implementation of inquiry processes in teacher-directed ways inevitably position students as passive recipients of knowledge rather than active learners. Classroom-based examples presented in this paper illustrate how pedagogical design can broaden and deepen the curriculum's intent. By incorporating systems-thinking, game-based learning and facilitating student-directed fieldwork, students will be better equipped to evaluate the environmental, economic and social dimensions of sustainability, recognise unequal impacts and come up with informed and ethical solutions to sustainability challenges.

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