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Incorporating Indigenous and Local Knowledge (ILK) Into a Climate Change Curriculum in Brunei Darussalam

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Abstract

This chapter presents an in-depth exploration of a university initiative to integrate indigenous and local knowledge (ILK) into a climate change curriculum for primary schools in Brunei Darussalam. Highlighting the work of the STEM Funds Project (Universiti Brunei Darussalam), the chapter demonstrates a participatory, community-based approach to curriculum development with the indigenous communities of Temburong, Brunei. This approach ensures that the curriculum both adheres to national educational standards, and is also deeply interwoven with the communities' ILK. The research was executed across three Iban-majority schools serving underprivileged indigenous communities, with two primary phases in its implementation process. Phase one involved conducting extensive interviews ($n=14$) and site visits ($n=6$) with key stakeholders in the Iban communities. The objective was to identify, understand and map the ILK embedded within these communities. In addition, the research sought to comprehend the communities' views on climate change. Phase two focused on developing a climate change curriculum for primary schools, underpinned by a community-based approach and the integration of the communities' ILK. The process involved the collaborative efforts of teachers, parents, and curriculum specialists through four study group sessions and an expert group meeting. The two research phases demonstrate how incorporating ILK can significantly enhance the climate change curriculum, making it more relevant and beneficial for indigenous children in the community. Overall, this chapter outlines the processes involved in developing a culturally relevant climate change curriculum, from identifying ILK to executing a participatory, community-based approach, which could have significant implications for researchers, teachers, children, and policymakers.

Keywords: Indigenous and local knowledge · Climate change curriculum · Primary school · Participatory research · Community-based approach · Curriculum development

1 Introduction

This chapter aims to illustrate a university initiative in Brunei Darussalam (henceforth Brunei) that integrates Indigenous and Local Knowledge (ILK) into a climate change curriculum for primary schools, focusing on both pedagogical approaches and research. Climate change is a major global issue that is adversely impacting Brunei's indigenous communities (Ali Hasan et al. 2016). Yet, as a topic, it is not sufficiently explored in the national curriculum (Sukri and Wah 2022), and the approaches that are employed fail to take into account indigenous communities' local knowledge systems (Alas 2017; Bakar and Franco 2022). Therefore, ILK is harnessed in this research to bridge the identified gap.

Usage of the term ILK is not without controversy, and its comparison with similar concepts such as 'traditional ecological knowledge' and 'local traditional knowledge' has been extensively debated in the literature (Aswani et al. 2018). Although a detailed discussion on terminology is beyond the scope of this research, a brief overview is offered here to foreground the selection of ILK. In essence, traditional ecological knowledge is defined as practices and knowledge passed down from generation to generation via cultural memory (Gómez-

Baggethun 2022), and local traditional knowledge incorporates knowledge of traditional techniques in areas such as subsistence and medicine (Reyes-García et al. 2013). Overall, ILK is a more holistic term that encompasses both these definitions. ILK is utilized in this chapter due to its increasing prevalence in scholarly work (Gómez-Baggethun 2022; Reyes-García et al. 2013) and its recognition by significant science-policy platforms such as the Intergovernmental Panel on Climate Change (IPCC) and Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES).

ILK is gaining growing attention in areas such as environmental conservation, climate change adaptation, sustainable development, scientific research and policy-making (Gómez-Baggethun 2022). Numerous interpretations of ILK can be found in the literature, with the majority centering on the concept of a cumulative body of knowledge, practices and beliefs handed down through generations by cultural transmission (Semali and Kincheloe 2002). A significant issue highlighted in scholarly research is the worldwide erosion of ILK, attributed to long-term global changes impacting local, peasant, and indigenous cultures (Reyes-García et al. 2013).

Education has the power to shape the future of a nation, and in Brunei, it holds great potential for creating a more equitable and just society. However, the legacy of colonialism has left its mark on education systems around the world (McQuaid 2009), and Brunei is no exception. This colonial legacy has led to the marginalization of ILK within the education system (Akena 2012). Such marginalization has a profound impact on children, teachers, and the broader community, limiting their opportunities to realize their full educational and personal potential (Lepore et al. 2021). This underscores the need to integrate ILK more effectively into educational practices to enrich learning experiences and honor local cultural heritage.

Decolonizing education, which refers to the process of dismantling the colonial legacy in education, by challenging dominant Eurocentric perspectives, privileging ILK, and promoting diversity and inclusivity (Wimpenny et al. 2022), is being increasingly practiced around the world. In order to create a more inclusive and empowering education system, it is therefore imperative to decolonize education in Brunei, as emphasized in the National Education System for the 21st Century (SPN21) (Ministry of Education 2013). This involves re-evaluating the curriculum and teaching methods to ensure that the knowledge and viewpoints of all children, including those informed by ILK, are valued and incorporated. One approach that holds promise for achieving this goal is participatory curriculum development (Auerbach 1992). This approach involves actively engaging children, teachers, and community members in the development and implementation of the curriculum, ensuring that ILK is effectively incorporated (Zamel and Spack 2002).

2 Integrating ILK Through Participatory Curriculum Development

The integration of ILK through participatory curriculum development is a dynamic approach that seeks to revitalize educational frameworks, fostering a deeper connection between learners and their cultural and environmental heritage (Mat Noor et al. 2023). Participatory curriculum development is a collaborative process that involves stakeholders, including the insights from ILK, in the creation and implementation of a curriculum (Martens et al. 2019). This approach recognizes the importance of involving children, teachers, parents, and community members, including those with ILK, in the decision-making process, and acknowledges their valuable knowledge and insights (DiSalvo et al. 2017). By involving stakeholders and incorporating ILK, the curriculum can be tailored to meet the needs and expectations of the local community, and can better reflect their values, beliefs, and cultures (Standley et al. 2022).

The participatory curriculum development process, including the integration of ILK, seeks to develop a more inclusive education system by promoting the active engagement and participation of all stakeholders, including bearers of ILK (Alexander and Hjortsø 2019). In turn, this can increase stakeholders' sense of ownership and responsibility, leading to better outcomes and a more effective implementation of the curriculum that respects and incorporates ILK (Weiss et al. 2021). Furthermore, by embedding ILK, participatory curriculum development can create a learning environment that is more attuned to the needs and aspirations of the local community, thereby fostering more engaged and motivated children that appreciate and learn from their indigenous and local heritage (Gubo et al. 2008).

Previous research has employed a range of methodologies when engaging in participatory curriculum development, including the concept of funds of knowledge, which aligns well with the principles of ILK. The funds of knowledge approach recognizes and values the cultural and intellectual resources, including ILK, that children and their families bring to the classroom (González et al. 2005). It is based on the idea that every child, regardless of their background or socio-economic status, has unique knowledge and skills, such as ILK, which they have acquired from their family, community, and culture (Moll et al. 1992). The funds of knowledge approach involves collaborating with children, families, and community members to identify and share the ILK that they possess (Hogg 2011).

By valuing and incorporating ILK into the curriculum, teachers can create a more inclusive and culturally responsive learning environment (Gay 2018). This can include things like cultural traditions, local ecological knowledge, or family histories. The funds of knowledge approach can also help to address issues of educational equity by recognizing and valuing the ILK that children bring from their homes and communities (Barton and Tan 2009). This in turn provides a way for teachers to build on the assets that children already possess, such as ILK, rather than focusing solely on their deficits (González et al. 2005). Overall, the funds of knowledge approach, with its inclusion of ILK, is a powerful tool for creating a participatory curriculum that is both culturally relevant and responsive to the needs and strengths of children and their communities.

3 Climate Change Curriculum for Primary Schools in Brunei

Climate change is a pressing concern that is affecting communities around the world, regardless of their location, or socio-economic background (National Research Council 2011). Its impacts are wide-ranging and can be observed in the form of extreme weather events, rising sea levels, biodiversity loss, and disruptions to ecosystems (Dandotiya and Sharma 2022). These changes directly impact communities and their livelihoods, making it essential for individuals to have a comprehensive understanding of climate change processes and their effects (Swim et al. 2011).

In Brunei, the effects of climate change have become evident through various observable changes. One significant impact is the increase in temperature, leading to hotter and more prolonged periods of heat (Ali Hasan et al. 2016). In addition, there has been increased rainfall, resulting in higher precipitation levels than what was previously experienced (Ali Hasan et al. 2016). The changing climate has also disrupted the patterns of fruit seasons in the area (Hosen et al. 2020). Traditional fruit-bearing trees, whose fruiting cycles were once predictable, are now exhibiting irregular patterns. This inconsistency can be attributed to the alterations in temperature and rainfall, which are affecting the natural growth and development of these fruits. Furthermore, the region has witnessed an increase in extreme weather events, such as flooding and landslides (Ndah and Odihi 2017).

In Brunei, the primary school curriculum has not adequately emphasized climate change, a concern that is particularly significant considering the global impact of climate change and its implications for future generations (Sukri and Wah 2022). Primary education plays a vital role in shaping young minds, yet in Brunei, the existing curriculum's lack of focus on this critical issue means that children are missing out on early exposure to the importance of climate change. This lack of emphasis is a major shortfall, as an understanding of the causes, effects, and potential solutions to climate change is essential for fostering an environmentally responsible and informed attitude from a young age (Ojala 2023). Without this foundational knowledge, children in Brunei may be ill-prepared to address or understand the environmental challenges they will inevitably face (Alas 2017).

As climate issues continue to escalate, it becomes crucial for the educational system in Brunei to integrate climate change education into its primary schooling framework. This integration should encompass teaching about the science of climate change, its specific impacts on Brunei, its socio-economic consequences, the importance of sustainable practices, and incorporating ILK relevant to Brunei's unique environmental context (Bakar and Franco 2022). Embedding this critical education early on is not just about raising awareness; it is about empowering the young generation to actively participate in meaningful environmental action (Ojala 2023). Instilling a deep respect for and understanding of the environment from a young age will enable Brunei to nurture a generation that is better equipped to tackle the challenges of climate change and more committed to pursuing sustainable solutions, ensuring the preservation of its unique environmental heritage (Sukri and Wah 2022).

4 Background of the Study

This university initiative on climate change education and research is based on the STEM Funds Project at Sultan Hassanah Bolkiah Institute of Education, Universiti Brunei Darussalam. The research aimed to develop and implement an interdisciplinary Science, Technology, Engineering, and Mathematics (STEM) climate change curriculum in three indigenous communities of Brunei (where Iban is the majority ethnic), using participatory action research and funds of knowledge approaches. The research began in May 2022 and was completed in April 2023.

The research process involved two distinct phases: curriculum exploration (from September 19 to November 10, 2022) and curriculum development (from November 10, 2022, to March 20, 2023). During the curriculum exploration phase, a series of 14 interviews and 6 visits were conducted with teachers, parents, and children in the three indigenous communities. The primary objective of this phase was to map out the ILK that exists within these communities, analyze their needs as part of the curriculum development process, and understand the communities' perspectives on climate change.

In the curriculum development phase, a participatory, community-based approach was employed to develop a climate change curriculum for primary schools (González et al. 2005). The development phase included four study groups and an expert group meeting. The study groups comprised teachers and parents who collaborated in the development of the curriculum, while the expert group meeting involved the participation of specialists who validated the curriculum. The Climate Change Curriculum for Primary Schools was created with the input and guidance of the communities involved to ensure that it was culturally relevant, engaging, and responsive to ILK. By using a combined participatory action research and funds of knowledge approach, the research sought to create a curriculum that was not only effective but also culturally sensitive and responsive to the needs of the communities.

The research focused on initiating a climate change curriculum in three primary schools located at the end of the Temburong Road. These schools were Sekolah Rendah Amo, Sekolah Rendah Semabat, and Sekolah Rendah Selapon, attended by Iban-majority communities rich in diverse cultural and traditional knowledge. Among the other indigenous children attending the schools are the Murut, Kedayan, Bisaya and Brunei-Malay. The selection of these schools was deliberate, as they serve underprivileged populations with limited access to educational resources. The three schools primarily cater to children from Iban communities, which are recognized as underprivileged communities within Brunei. Unfortunately, a significant number of these children face additional challenges, such as lack of access to government school meals and transportation support. These difficulties arise from the Iban's unique status, distinct from other indigenous Malay communities, as they were regarded as non-citizens or permanent residents (King and Knudsen 2021).

Through the research, the Iban communities in these schools had the opportunity to participate in the development of a climate change curriculum that was culturally relevant, engaging, and reflected their ILK, thus addressing existing educational disparities.

5 The Participants

The research participants were children, teachers, parents, academics and government officers in Brunei. Through the participatory curriculum development approach, stakeholders, including bearers of ILK, were actively involved in shaping a climate change curriculum. Their contributions helped inform and develop a curriculum that was not only more responsive to cultural diversity and inclusive of different perspectives, but also effective in achieving its educational goals, especially in the context of climate change education. Teachers benefitted from the research by gaining valuable insights into the needs and values of the indigenous communities. They were also able to provide feedback on the climate change curriculum and participate in its development. This involvement helped teachers feel more empowered and invested in the success of the climate change curriculum, leading to more effective teaching practices (Carl 2009). Parents were also involved in the research. This offered them the opportunity to have their voices heard in relation to their children's education, and helped them better understand the curriculum and its relevance to their community (Huang and Mason 2008). It also encouraged them to support their children's learning, and to be more engaged in the educational process (Mapp 2003).

In addition to the teachers and parents, the officers/researchers, academic community and children also participated in this participatory, community-based research. The officers/researchers and academic community benefitted by gaining valuable insights into the participatory curriculum development approach and its potential to create a more inclusive and culturally responsive education system. The findings and recommendations of the research will also inform further research and contribute to the development of best practices in curriculum development. Finally, the research will have a significant impact on children, as they will be the direct recipients of the curriculum. An enhanced and inclusive curriculum has been developed, with a strong emphasis on incorporating the perspectives and inputs of children. This inclusive approach is particularly crucial when designing a curriculum focused on addressing climate change (Kerr et al. 2022). Historically, children's voices have often been ignored or marginalized, but it is imperative that they are actively involved in shaping the curriculum. Consequently, the children have played an integral role as both participants and beneficiaries of this research.

A total of 119 individuals participated in the research, including academics ($n=8$), officers ($n=15$), research assistants ($n=9$), children ($n=24$), teachers ($n=28$), and parents ($n=35$) (as

shown in Table 1). This diverse group of participants brought different perspectives and experiences to the research, which enriched the participatory curriculum development approach and contributed to its process. The participating individuals came from three main institutions: universities, schools, and the Ministry of Education, as illustrated in Table 2. This collaborative effort brought together different stakeholders with diverse backgrounds and expertise, creating a comprehensive and inclusive approach to curriculum development.

Table 1 The total number of participants involved in the research.

No.	Demographic of participant	Number of people
1	Academics	8
2	Officers	15
3	Teachers	28
4	Research Assistants	9
5	Children	24
6	Parents	35
Total		119

Table 2 The distribution of participants based on the institutions involved in the research.

No.	Institution	Number of people
1	Universities	12
2	Schools	87
3	Ministry of Education	20
Total		119

During phase one of the research, data were collected using a range of qualitative research methods. This included teacher interviews, focus group interviews with children, and household visits (as shown in Table 3). A total of seven teachers from the three participating schools were interviewed in five group interview sessions, providing valuable insights into their perspectives on curriculum development. For the focus group interviews, 24 children participated in nine sessions (two to three children per session). These sessions provided an opportunity for the researchers to engage directly with the children, gaining an understanding of their ILK and views on climate change. In addition, six household visits were conducted in three fieldwork locations in Temburong, during which 10 parents, including one Village Head, were interviewed. These visits provided an opportunity to understand the ILK embedded within the indigenous communities and their perspective on education and the relevance of the climate change curriculum to their everyday lives. Overall, these data collection methods provided a comprehensive understanding of the needs of the communities and their perspectives on education, ILK, and climate change, which informed the participatory curriculum development approach taken in phase two of the research.

Table 3 The types of data and number of participants involved in phase one of the research.

No.	Session	Number of sessions	Number of participants
1	Interviews with teachers	5	7
2	Focus group interviews with children	9	24
3	Household visits	6	10
Total		20	41

In phase two of the research, four study groups and one expert group meeting were conducted to develop the curriculum. The four study groups involved 63 individuals and the expert group meeting involved 31 individuals. The number of sessions conducted, and the number of participants involved in phase two is illustrated in Table 4.

Table 4 The number of sessions conducted, and the number of participants involved in phase two of the research.

No.	Session	Number of sessions	Number of participants
1	Study groups	4	63
2	Expert group meeting	1	31
	Total	5	94

6 Phase One: Curriculum Exploration

The use of an ethnographic approach in phase one (from September 19 to November 10, 2022) offered an effective way to develop a climate change curriculum incorporating ILK. This approach involved observing, interviewing, and interacting with the community to understand their values, beliefs, and practices. By doing so, the researchers were able to capture their ILK, which refers to the skills, knowledge, and expertise that individuals and communities possess. This knowledge is often passed down from generation to generation and is deeply rooted in their cultural traditions and practices (Semali and Kincheloe 2002). In general, the primary objective of phase one was to map out the ILK of the three indigenous communities in Temburong, which was subsequently used to develop a climate change curriculum. In addition, this phase aimed to identify the communities' curriculum development needs and ask questions related to sustainability.

In the context of curriculum development, ILK was vital in phase one. This knowledge served as a valuable resource that the researchers could draw upon to create a curriculum that reflected the unique ecological, linguistic, and cultural context of the Temburong community (Gay 2018). For instance, by incorporating ILK, this research led to the creation of a climate change curriculum that promoted sustainable practices and highlighted the importance of biodiversity conservation (Barraza and Bodenhorn 2012). Likewise, by incorporating the local language and cultural practices, it generated materials that were more accessible and engaging for the children, as they could see themselves and their community represented in their learning (Mat Noor et al. 2023).

The data collection process for phase one commenced in March 2022 with the lead author embarking on a camping trip to Temburong. During this trip, he explored the area and engaged with the indigenous communities. Following this, he and the second author visited schools in the area to ascertain which ones could potentially be collaborators and school partners for the research. Fortunately, three schools agreed to participate voluntarily, and the fieldwork for phase one was subsequently conducted from September 19 to September 22, 2022. During this fieldwork period, five interviews were conducted with teachers, nine focus group interviews were held with children, and five households were visited. The lead author and the remaining authors also held a discussion with children's parents and the Village Head on November 10, 2022, to further ensure that the research collected an allotted amount of data for saturation.

6.1 Teacher Interviews

A total of five teacher interviews were conducted with seven teachers during phase one of the research. Two of the interviews were conducted using a focus group approach, while the remaining interviews were conducted one-to-one. The teachers were chosen based on recommendations from the school principals. During the interviews, an unstructured interview methodology was utilized, with three key focus areas in mind: identifying community needs for participatory curriculum development, mapping out the ILK of the communities, and exploring climate change and sustainability teaching practices among the school communities. As shown in Figure 1, each interview lasted for around 20-40 minutes and was conducted in an open and safe environment. Through this process, the researchers gathered valuable insights that informed the development of the curriculum.



Fig. 1 The purpose of the research was clearly communicated and used accessible language to ensure that the teachers felt at ease and understood the research goals.

Excerpt 1 illustrated a response from the teachers who were asked what is special about their school, based on their years of experience teaching there.

Researcher: So, based on your experience... years here, what do teachers feel is so special about this school?

Teacher 1: The most exciting part is the adventure aspect. Especially when we wake up early and come to school, entering the forest, exploring like this, you know? Breathing in the fresh air, oxygen... Every morning. So, for the past... years, teaching in the wilderness has truly been a joy. I feel like I'm entering my own village. In fact, I have many relatives here...

Teacher 2: Firstly, the fresh air, and secondly, the familiarity of the place. For me, I really enjoy the school being located in the wilderness. I feel that the school environment is stimulating, and I am particularly delighted to interact with children who are in the wilderness, like those we have now. And what's more, the children's lively personalities don't burden my mind too much...

(Excerpt 1)

Teacher 1 mentioned that what makes the school special is its sense of adventure, particularly as they need to wake up early in the morning and come to school by walking through the forest, deep in the jungle. They also highlighted that teaching in the interior for years has been a pleasure and that they feel like they are entering their own village as they have many relatives nearby the school. Another teacher (Teacher 2) discussed how the fresh air and familiar place are special elements. They enjoy teaching in the interior because they find the school environment to be conducive to experiential learning, and they like dealing with the children, since they are lively and inquisitive.

The teachers' words suggest that they have a deep understanding and appreciation of the local environment and the community. They acknowledge the unique aspects of the school's location in the forest and value of the opportunity to teach in such an environment. The teacher also mentions having many relatives in the area, indicating a strong connection to the local community and culture. Furthermore, the teacher also recognizes the importance of a stimulating school environment and how it can positively impact the teaching and learning process. They appreciate the liveliness of the children, highlighting their level of engagement and enthusiasm, which makes teaching an enjoyable experience. This implies that the teacher is committed to providing high-quality education to the children and understands the significance of creating a positive learning environment to ensure their success.

In a different interview session (see Excerpt 2), a group of teachers were discussing ways to improve the science textbook used in their school.

Researcher: So, for science... how can we improve the textbook?

Teacher 3: If it's for Year 4 and upper, it's okay, but for Year 1 to Year 3, I think we need some additions. Some parts are too complex and not suitable. There is a lack of information, and, umm, some vocabulary needs to be reduced, like in Year 3, currently. Even the illustrations mostly feature white people.

Researcher: Do you think it would be better if we include more context relevant to Brunei?

Teacher 4: It would be more user friendly... Yes, like how we explain MIB (Malay Islamic Monarchy). For example, there is no MIB context in the textbook.

Researcher: Why don't we introduce the different types of words used in Brunei, the different types of fish... Proboscis monkeys are not mentioned in the textbook.

Teacher 3: Yes, we have to search for them on the website ourselves.

Researcher: So, I think we need to localize our textbook, right?

Teachers 3 & 4: Exactly.

(Excerpt 2)

One of the teachers (Teacher 3) pointed out that while the textbook is suitable for upper-level children, it needs to be adapted for years one to three, as some topics are too complex. The teacher also suggested simplifying the vocabulary and adding more about the context of Brunei to ensure that it was more relatable for the children. They agreed that local content such as types of words used in Brunei, as well as examples of local wildlife endemic to the region, such as certain types of fish, and proboscis monkeys, should be mentioned in the textbook. The teachers acknowledged the need for localization and agreed that the textbook needs to be adapted to suit the local context.

The teacher's words suggest that there is a need for participatory curriculum development that integrates ILK. This highlights the importance of involving teachers, children, and the existing community in curriculum development research to ensure that it is relevant and appropriate to the local context. By incorporating ILK, children can relate to the materials,

making it easier for them to learn and retain information. When children see themselves and their culture represented in the curriculum, they are more likely to feel a sense of belonging and ownership over their learning (González et al. 2005), which in turn can lead to greater engagement and a more positive attitude towards learning. This participatory approach recognizes the value of local knowledge and ensures that it is integrated into the curriculum.

6.2 Focus Group Interviews

A total of nine focus group interviews were conducted with a diverse group of 24 children from participating schools, ranging in age from 6 to 12 years old. The selection of children was made by the school principals, who identified children that would be willing and able to participate in the research. All interviews took place in a quiet and comfortable setting within the school premises. Prior to commencing the interview, the children were consulted regarding their willingness to participate in the research, and they were requested to sign an assent form as an indication of their agreement. In addition, the children's parents were also consulted and asked to sign consent form during this process. As shown in Figure 2, the focus group interview was chosen as the methodology rather than the one-to-one interview approach because it provided a more dynamic and interactive setting for the children to share their perspectives and experiences with each other (Barbour 2014). This allowed the researchers to gain a deeper understanding of the thoughts and feelings of the children on the topic under discussion. Each interview lasted for approximately 15 to 30 minutes, which was deemed an appropriate amount of time to ensure that the children did not become too restless or disengaged during the process.



Fig. 2 Children participated in a focus group interview.

A structured interview method was implemented to maintain uniformity in the questions posed and facilitate data interpretation. The choice of a structured approach for the interviews with children, as opposed to the semi-structured methodology applied during household visits, was deliberate. This structured approach was adopted to maintain focus and ensure that the interviews remained on topic, which is crucial when engaging with younger participants who

might require more guidance to stay aligned with the interview objectives. The focus group interview was divided into three main components: mingle questions, questions to elicit ILK with regards to children's activities at home and outside school, and questions related to climate change. The first component was employed to build rapport with the children and make them feel at ease. Meanwhile, the second and third components were analyzed through reflective thematic analysis. Following Braun and Clarke's (2021) process for conducting reflective thematic analysis, the researchers familiarized themselves with the data and generated initial codes, which represented meaningful units. These codes were then organized into potential themes, and through a process of review and refinement, the researchers defined and named the themes. Throughout the analysis, the researchers engaged in critical reflection, by acknowledging their own biases and assumptions. The themes were interpreted within the broader context of the interview objectives, and insights and explanations were generated based on the analysis.

In relation to the children's views on climate change, five themes were generated, including awareness, impact, cause, mitigation, and adaptation (as illustrated in Table 5). This approach allowed for a systematic and comprehensive analysis of the data collected. While the children lacked knowledge of climate change terminology, they demonstrated a basic understanding of weather patterns and recognized the effects of climate change on their environment and animals. Some children correctly identified the causes of floods and understood the connection between weather patterns and natural disasters. They also displayed resourcefulness by suggesting online learning as an alternative during extreme weather events. The children showed a commendable understanding of mitigation strategies such as reducing plastic usage, practicing the 3R principle (reduce, reuse, recycle), and repurposing old items. Their actions demonstrate the potential for positive change and emphasize the importance of addressing climate change for the well-being of communities, particularly vulnerable ones like those of the children involved in the research.

Table 5 The results of focus group interviews conducted with children on the topic of climate change.

Themes	Results
Awareness	Across the interviews, the children generally have limited awareness of the term <i>perubahan iklim</i> (literally translated as climate change). In many cases, they had not heard of it before: • “<i>Pernah dengar perubahan iklim?</i>” (literally translated as Have you ever heard of climate change?) – The children often responded with “<i>Inda</i>” or “<i>tak pernah</i>” (literally translated as No)(Transcript - FGI1)(Transcript - FGI2)(Transcript - FGI3)(Transcript - FGI6). However, when it comes to understanding weather changes, they have a clearer awareness, particularly concerning <i>banjir</i> (literally translated as floods) and <i>kemarau</i> (literally translated as droughts), which they have personally experienced or heard about (Transcript - FGI1)(Transcript - FGI11)(Transcript - FGI3)(Transcript - FGI8). Children frequently mentioned specific weather patterns such as heavy rains and droughts, but often lacked understanding of the broader concept of climate change.
Impact	Flooding and heatwaves were the most commonly reported impacts:

	• “<i>Pernah arah Ulu. Di Kg Kenua</i>” (literally translated as There has been flooding in Ulu, Kenua village)(Transcript - FGI1)(Transcript - FGI4)(Transcript - FGI2)(Transcript - FGI5)(Transcript - FGI8). • Heatwaves were described as causing discomfort, skin darkening, and even forest fires (Transcript - FGI4)(Transcript - FGI5)(Transcript - FGI8). Other impacts included tanah susur (literally translated as landslides) and less fertile land during drought periods (Transcript - FGI1)(Transcript - FGI1)(Transcript - FGI3). The children reported that landslides typically occurred after heavy rain in areas where there were fewer trees (Transcript - FGI1)(Transcript - FGI6)(Transcript - FGI9).
Cause	While the children demonstrated a basic understanding that weather events like flooding are caused by heavy rain, they were less clear on the underlying causes of broader climate changes: • Flooding was usually attributed to <i>hujan lebat</i> (literally translated as heavy rain)(Transcript - FGI1)(Transcript - FGI3)(Transcript - FGI7)(Transcript - FGI8). • For landslides, they understood the role of both rain and deforestation. One child mentioned “<i>pasal pokok banyak kena tebang</i>” (literally translated as because many trees were cut down) (Transcript - FGI2)(Transcript - FGI6). The children also recognised human actions like improper waste disposal and exhaust emissions as contributing to environmental problems (Transcript - FGI1)(Transcript - FGI7). One child connected industrial pollution with gas emissions, suggesting that these affect the environment (Transcript - FGI7).
Adaptation	Adaptation strategies were not extensively discussed by the children. In most cases, the focus was on experiencing these events rather than actively adapting to them. However, a few children mentioned taking practical steps like online learning when schools were inaccessible due to flooding (Transcript - FGI6). There were also references to coping with hot weather, but no deeper discussions of adaptive strategies.
Mitigation	The children mentioned several mitigation strategies, though often with limited detail. Key actions discussed include: • Planting trees to combat deforestation and reduce the risk of landslides and other problems (Transcript - FGI1)(Transcript - FGI8)(Transcript - FGI7)(Transcript - FGI9). • Using bicycles instead of cars to reduce pollution and curb emissions (Transcript - FGI6)(Transcript - FGI8)(Transcript - FGI9). • Proper waste management, with mentions of reducing, reusing, and recycling waste (Transcript - FGI5)(Transcript - FGI8). Children were aware of the importance of keeping the environment clean, particularly to prevent land pollution.

The concept of replanting trees after cutting them down was recognised as a renewable solution (Transcript - FGI7).

6.3 Household Visits

In addition to conducting teacher interviews and focus group interviews, the research employed a distinctive approach to data collection, which involved visiting households. This approach was adapted from the funds of knowledge framework and aimed to capture detailed information about the ILK and experiences of the indigenous communities (González et al. 2005). Six households were visited, some of which were still living in longhouses (as shown in Figure 3), with a total of 10 parents participating in the interviews. The school principals recommended the specific households that could be visited, and provided logistical and technical assistance throughout the process. During the visits, a semi-structured interview method was used to ask about the daily lives and routines of the household members. The semi-structured method allowed for a flexible and responsive interaction, enabling researchers to explore topics deeply and adapt to the flow of conversation. This flexibility was particularly valuable in capturing the nuanced and complex realities of the participants' lives and their interactions with their environment. They also inquired about the signs of climate change and changes in weather patterns in the Temburong district. In addition, households' surroundings were explored to gain a better understanding of their environment.



Fig. 3 One of the longhouses in the district, during the household visit.

Excerpt 3 highlights the extensive knowledge and expertise that the family holds when it comes to gardening.

Gardening is a hobby that runs in our family. Our father-in-law is an avid gardener, and even our sisters have taken up gardening as a pastime. When the crops grow well

and the soil is fertile, we are rewarded with a bountiful harvest. We often sell some of our produce, such as the hundreds of bitter beans we obtained from our recent harvest. There are two types of bitter beans we grow: village bitter beans and agricultural bitter beans. The village variety has a tangy and spicy taste, while the agricultural type is less so. The seeds for the agricultural bitter beans were imported from Thailand, as the village variety takes years to produce fruit, and even then, it's not a guarantee. On the other hand, the agricultural bitter bean plants can produce fruit within five to six years, which is much more efficient. Our younger brother has taken it upon himself to grow about 40 to 50 bitter bean trees, and all of them produce lots of fruit. If the weather permits, we can even take a stroll through the garden behind our car garage, which is nestled under a picturesque hill.

(Excerpt 3)

It is evident that gardening is a shared hobby among family members, and they have been practicing it for a long time. The parents speak of their father-in-law and sisters' passion for gardening, which indicates that gardening has been a part of their family for generations. Furthermore, the parents demonstrate a deep understanding of the different varieties of bitter beans they grow, such as the village bitter beans and agricultural bitter beans. They explain the differences in taste between the two types and even provide insights into the growing process, including how the agricultural bitter bean seeds were imported from Thailand. In general, the excerpt suggests that the parents and their families are passionate about gardening and take pride in their produce. They appear to have deep knowledge of the different types of bitter beans they grow and are invested in maximizing their yield.

In a different interview (see Excerpt 4), one parent reveals that they have experience in preparing traditional Iban cuisine, such as bamboo chicken, bamboo fish, and cassava shoot mixed with torch ginger. While bamboo chicken is not something they make frequently, they do prepare it during special occasions such as the Gawai festival.

Sometimes I make bamboo chicken, although it's not that frequent. I only do it when I have ample time. During the last Gawai festival, we cooked a lot of bamboo chicken. One of the traditional Iban dishes that I usually make is bamboo chicken, along with cassava shoots mixed with torch ginger and bamboo fish. We usually use freshwater fish such as silver catfish and rasbora fish or catfish to make bamboo fish.

(Excerpt 4)

The parent mentions that bamboo chicken is a traditional dish made by cooking chicken in a bamboo tube. They also highlight that they use other ingredients, such as cassava shoots and torch ginger, in their cooking. In addition, they describe how they make bamboo fish, which is prepared in a similar way to bamboo chicken but using fish instead. The parent also provides examples of the types of fish they typically use in bamboo fish, including freshwater fish like silver catfish and rasbora fish. This indicates that the parent has knowledge of the different types of fish that are available in their local area and the ones that are most suitable for certain dishes.

Excerpts 3 and 4 highlight the two examples of ILK that are prevalent within the indigenous communities: gardening and traditional cooking. It showcases the rich tradition of knowledge and skills that these families possess, which have been passed down from generation to generation. From the household visits, we identified five main themes that represent the ILK held by these communities. These themes are agriculture, foraging and hunting, fishing and river activities, household management, and business and economic activities (see Table 6).

Table 6 The ILK identified in three indigenous communities during phase one of the research.

<i>Themes</i>	<i>Description</i>
Agriculture	Agriculture is a vast and essential aspect of the indigenous community's ILK. It encompasses a wide range of skills such as construction skills, gardening skills, and generational traditions that have been passed down through families. The community's livelihoods also heavily depend on agriculture, as many households engage in farming as their primary occupation. The types of rice, fruits, flowers, and vegetables that are grown in the community are also a significant aspect of this theme.
Foraging and hunting	Foraging and hunting refer to the practices of gathering wild food resources such as animals, vegetables, leaves, and fruits. It encompasses various aspects such as community beliefs, foraging and hunting skills, tourism, and occupations. In Temburong, foraging is deeply ingrained in the culture and traditions of the community, with many relying on it as a source of food and income.
Fishing and river activities	The category of fishing and river activities includes various aspects such as fishing processes, school activities related to the river and fisheries, occupations (many are part-time fishermen), household management related to river activities, leisure activities related to rivers, and generational traditions. In addition, this category includes different types of fish and river species that can be found in the area, as well as the types of baits that are commonly used for hooking fresh giant water prawns.
Household management	Household management encompasses various aspects of daily life such as cooking for festive occasions, traditional cuisine preparation using sustainable methods, and a focus on healthy cooking methods such as boiling and steaming.
Business and economic activities	Business and economic activities encompass a variety of skills and products developed within the community. Some households sell plants, hunted animals, and traditional foods at festive markets, longhouses, and Nemuai Sales. Other products include canes, hot wood, and machetes, which are sold at the Village Head's house. The community members also engage in weaving, sell traditional Iban shirts, and produce handicrafts such as handbags, mats, baskets, and beaded flowers. These skills require expertise in weaving, sewing, embroidering, and other forms of craftsmanship. The community's entrepreneurial spirit is evident in their ability to use their traditional skills to generate income and support their families.

7 Phase Two: Curriculum Development

In phase two, from November 10, 2022 to March 20, 2023, a climate change curriculum was developed based on the ILK identified in phase one. Given the importance of climate change in Brunei and the curriculum needs identified in phase one, it was decided that an interdisciplinary climate change curriculum would be developed. Recognizing that the themes emerging from the earlier phase were intrinsically linked to climate change, it became evident that an interdisciplinary approach to curriculum development was necessary. Four study group workshops were conducted with the participation of 63 teachers and parents. The purpose of these workshops was to gain insights from teachers and parents that could inform the development of the curriculum. An expert group meeting was also held on March 20, 2023, which involved 31 university academics, curriculum specialists, educational researchers, and schoolteachers. The workshops and expert meeting served as platforms for the experts to evaluate the feasibility of the curriculum and provide feedback to improve its content and implementation.

7.1 Study Groups

Each of the study group workshops was conducted on separate days between November 2022 and February 2023, with two workshops taking place at Sekolah Rendah Amo and one workshop at Sekolah Rendah Semabat and Sekolah Rendah Selapon, respectively. Each session, which was two hours long, was further divided into three to four focus groups, consisting of an academic, a Ministry of Education officer or i-Ready apprentice, teachers, and parents. Meanwhile, an unstructured interview discussion method was used to facilitate the focus group discussions, each of which lasted for 30 minutes to an hour. The use of unstructured interviews in the focus group discussions was a strategic choice designed to foster an open, flexible dialogue among participants. The goal is to uncover insights and understandings that might not emerge through more rigid, structured inquiry methods. Based on the analysis of the discussions, three common themes were identified: agreement, concern, and suggestion. The results of the discussions based on these three themes are presented in the following sections.

7.1.1 Study Group 1

Study Group 1, consisting of three focus group discussions, was held at Sekolah Rendah Amo on November 11, 2022 (see Figure 4).



Fig. 4 One of the focus group discussions on ways to incorporate ILK into a climate change curriculum

During the discussion, teachers and parents expressed their concerns about the lack of local knowledge being practiced by the younger generation (see Excerpt 5).

Interviewee 1: Because nowadays, many people don't go out, and parents are too protective. It's not like before when we used to go to the paddy fields or elsewhere.

Interviewee 1: Nowadays, it's not happening.

Researcher: Why is that?

Interviewee 1: The parents only go, and they employ Indonesian workers.

Researcher: Ah, what?

Interviewee 1: Indonesian workers.

Researcher: Why...? Employ... What do you mean...?

Interviewee 2: These workers... they hire many workers...

Researcher: They hire workers to work in the plantations. Oh... outsiders. Okay, okay, so there aren't many local people.

Interviewee 1: Because their children are studying, and they don't want to disturb them, so they don't know much sometimes.

(Excerpt 5)

In the above excerpt, the interviewees noted that children nowadays are not involved in farming or gardening as much as they used to be. In the past, children followed in their parents' footsteps by working on the farm. However, nowadays, parents are more protective of their children and want them to focus more on their studies, believing that formal education is as important as other things. As a result, local farming is now mostly done by foreign workers and many of them are from Indonesia. In addition, the study group also highlighted their concerns about the terminology used in the proposed climate change curriculum. Local children are not familiar with some of the terminologies used. For instance, the study group raised concerns that children may confuse strawberries with cherry tomatoes or mulberries, as strawberries are not commonly found in the Temburong district. Regarding suggestions, teachers and parents

recommended using Malay as a teaching medium, as children are more familiar with this language and can understand it better than English.

7.1.2 Study Group 2

Study Group 2 was held at Sekolah Rendah Semabat, on February 8, 2023, and involved four focus groups (see Figure 5). The participants expressed their support for the climate change curriculum, but also raised concerns about the loss of ILK and language issues. According to the teachers and parents, children these days are not interested in local traditions, and the quality of traditional crafts, such as the making of *parang* (literally translated as machetes), has deteriorated. Most children also lack the skills needed for local practices such as fishing, farming, foraging, and textile weaving. Moreover, children are not familiar with local names, such as the names of different types of rice. The major concern discussed in this study group was the lack of content on climate change in the Social Studies syllabus. The climate change content in the textbook is too generic and does not feature any examples from Temburong. Furthermore, the Social Studies syllabus does not provide a detailed explanation of the causes of climate change and mainly focuses on mitigation strategies. This leads to children learning less than they did in Geography, before this subject was replaced by Social Studies.



Fig. 5 Study group 2 involved the participation of the majority of teachers and parents from the school.

In response to these concerns, teachers/parents themselves suggested several strategies, in conjunction with the researchers. One effective approach would be to incorporate the climate change curriculum not only into Social Studies but also into other subjects such as Science, Malay and the Malay Islamic Monarchy (MIB). This would allow children to learn about climate change in a more integrated and comprehensive manner. Participants highlighted that in the case of lower primary children, for whom Social Studies is not part of the curriculum, sensory learning through hands-on and visual activities could be an important method for effective learning. Participants also emphasized the importance of integrating local knowledge,

such as the names of different types of rice, into the curriculum. Furthermore, workshops should be provided for parents to learn more about climate change so that they can support their children's learning at home.

As per Excerpt 6, teachers suggested that the curriculum should be taught in Malay as children can better understand this language than English, thus enhancing their learning experience. However, the curriculum should use words that are more familiar to the local community. For example, the term *inflasi* (literally translated as inflation) can be replaced with *kenaikan harga* (literally translated as price increase) for easier understanding. By implementing these strategies, children can learn about climate change more effectively and in a way that is relevant to their local context.

Researcher: So, if Year 4, 5, and 6 have Social Studies, where should we include it for Year 1, 2, and 3... based on the data we have?

Interviewee 3: We can include it in MIB (Malay Islamic Monarchy).

Researcher: Okay. Is MIB included in Year 1?

Interviewee 3: Yes. From Year 1 to 4.

Researcher: From which perspective? Talking about climate change, for example.

Interviewee 3: Well...

Researcher: Regarding that, they only start introducing it in Year 4. We want it to be earlier, right?

Interviewee 3: Maybe in Science. If it's about that, the Science subject can cover it. But if there isn't, then I'm not sure. Even in Science, the content for Year 1, 2, and 3 is limited.

Interviewee 4: The problem is the limited content. If...

Interviewee 3: Yes, it's limited. And once it's Year 4...

Interviewee 4: If we add that, it becomes an extra topic. One topic.

Interviewee 3: In Year 4, 5, and 6, the teaching is not extensive.

Researcher: I see. But they haven't changed the teaching methods. That's what we'll change.

Interviewee 3: Maybe we can include it in Science.

Researcher: In Science. Are there any other examples?

Interviewee 4: Bahasa Melayu.

Researcher: Ah, Bahasa Melayu.

(Excerpt 6)

7.1.3 Study Group 3

The following study group took place at Sekolah Rendah Selapon on February 21, 2023, and featured three focus groups (see Figure 6).



Fig. 6 Participants of one of the study group discussions engaged in an in-depth discussion about the proposed climate change curriculum.

Participants strongly supported the incorporation of ILK into the climate change curriculum and felt that the proposed curriculum is suitable for primary level children (see Excerpt 7). However, some learning objectives, such as problem-solving related to climate change mitigation and understanding the effects of climate change and mitigation strategies, were identified as potentially challenging for children due to a lack of exposure to these topics. The loss of local knowledge and terminology used also continued to be significant issues. For instance, the skills needed to make the popular dish *nasi bungkus* (literally translated as wrapped rice) are no longer commonly acquired among young people, and the language used in the curriculum is sometimes difficult for children who are not familiar with terminology related to climate change to understand. To address this, participants suggested using more appropriate words, such as *hujan lebat* (literally translated as heavy rain) instead of *banjir* (literally translated as flood), and introducing the word *lestari* (literally translated as sustainable) as a different concept from reading, as it is commonly associated with the school reading program (see Excerpt 8).

Researcher: Ok. So, is it okay? (referring to the ILK map). Satisfied. Is it okay?

Interviewee 5: Ok.

Interviewee 6: Ok.

Researcher: Does anyone disagree?

Interviewee 5: Very much in agreement.

Researcher: Does anyone find it difficult to agree?

Interviewee 5: Very much in agreement.

Interviewee 6: Everything is already here.

Researcher: Is it complete?

Interviewee 6: Complete.

(Excerpt 7)

Interviewee 7: A sustainable strategy, we must introduce it here. This is my first time too. The only concept I'm familiar with is the sustainability program. It's a reading program.

Interviewee 5: Yes...

Interviewee 7: For me, sustainability is just about reading. But you said...

Researcher: Is there a sustainability program?

Interviewee 5: Yes.

Researcher: Reading.

Interviewee 7: Usually, it's a reading program. When we hear sustainability, it's like that.

Researcher: Oh... oh... okay.

Interviewee 5: Using standard language.

Interviewee 7: When you use the terminology unsustainable practice, it encompasses everything, right? So, it means...

Researcher: Not sustainable.

Interviewee 5: Reading.

Interviewee 7: It has a different meaning, right?

(Excerpt 8)

Participants in the study group proposed several effective approaches for teaching the climate change curriculum. The most widely recommended approach was the use of multimedia tools such as pictures, videos, analogies, and animations. Other suggested methods included encouraging children to engage in personal research and organizing field trips to logging sites and forests. Teachers could also introduce the topic of climate change through daily activities, such as discussing how flooding impacts agriculture and local communities. Parents were also highlighted as key figures in teaching their children about climate change. They can achieve this by practicing sustainable living at home, notably reducing plastic usage and composting food waste. To enhance children's interest in traditional practices, such as farming or gardening, participants suggested incorporating discussions of modern techniques like hydroponics and greenhouse farming into the teaching of various subjects such as Science and Social Studies. Workshops with specialists can be organized to teach these techniques to both teachers and children. These approaches can in turn help children learn about climate change in a practical and engaging way, both in school and at home.

7.1.4 Study Group 4

The final study group, Study Group 4, was conducted at Sekolah Rendah Amo on February 22, 2023, and involved four focused discussions (see Figure 7). During the discussions, teachers and parents expressed concerns that younger generations are not familiar with local traditions since they are no longer practicing them. For instance, children are not interested in farming or gardening, as the weather is scorching, and they prefer to go home early. Furthermore, parents are working full time, and they do not have time to practice ILK with their children. In the past, some participants shared that their parents made *bubu* (literally translated as a fish trap) using plastic bottles. By contrast, the children only observed how things were made, but they did not learn how to make products themselves. Previously, ILK was easier to pass down to the younger generation since children spent more time farming and going to the forest with their parents. However, nowadays, children tend to read more and practice less, making it difficult for them to engage with indigenous and local activities they have never experienced before. Another common concern raised during the discussions was the issue of language and

terminology, particularly for Year 1 and Year 2 children who are still very attached to their mother tongue (majority Iban language). Some terminology used in the curriculum may not be familiar to them, making their learning experience challenging. For example, Year 1 children are not familiar with the word *kemarau* (literally translated as drought), and instead, they use *panas* (literally translated as hot) to describe sunny weather.



Fig. 7 Study Group 4 had the highest number of participants, consisting of teachers and parents who actively engaged in the discussions.

The current Social Studies syllabus is lacking in content, resulting in children having limited knowledge of climate change. Participants of the study group suggested using various teaching approaches such as showing pictures, videos, and animations; engaging with social media; organizing field trips; report writing; using examples from daily life; and organizing competitions. While English is an acceptable medium of instruction, participants preferred Malay or even Iban language as the primary teaching medium. However, the implementation of the climate change curriculum will require support from all stakeholders. Useful tools could include the provision of workshops for teachers and parents to enhance their knowledge, and addressing the challenges they face in balancing their busy work schedules (see Excerpt 9). Adequate budgetary support is also essential to ensure the success of the curriculum. Despite the willingness of many parents to support their children's learning on climate change, time constraints and low energy levels after work pose significant challenges.

Interviewee 8: So, in order to propose this kind of thing, you have to fully support us and fully equip us.

Researcher: What does support mean? Parents? Ministry of Education?

Interviewee 8: Support, in this context, means that we must have sufficient resources. Like, we need to know our time constraints, and we might feel somewhat lacking in certain areas.

Researcher: In terms of budget, perhaps?

Interviewee 8: Yes, of course. Support encompasses...

Researcher: Everything?

Interviewee 8: Yes, everything. It doesn't mean that we don't want to do it. It's good to do it. It's just that sometimes, there are constraints in that timeframe.

Researcher: It means that everyone agrees, provided that there is support.

Interviewee 9: If there is support, we can carry it out.

Interviewee 8: If there is support, sometimes it's not a problem for us to communicate.

But to take action, we need strong support from behind.

Researcher: From all the experts... that's the support.

(Excerpt 9)

7.2 Expert Group Meeting

The expert group meeting was held on March 20, 2023, at the Sultan Hassanal Bolkiah Institute of Education, Universiti Brunei Darussalam (see Figure 8). The expert group played an integral role in the systemic participatory research approach, which employed the nominal group technique. This is a structured method for group brainstorming that encourages contributions from everyone, following a participatory research process (Hegarty 1977). Since climate change is an interdisciplinary topic that should be taught in primary schools, the research involved gathering experts from across various fields such as Science, Technology, Engineering, Arts, and Mathematics (STEAM) education. The experts involved in this research comprised academics specializing in various subjects such as Science, Mathematics, Malay Language, English, and Arts. The group also included curriculum specialists in Science, Mathematics, and Social Studies, as well as researchers from the Ministry of Education. In addition, experienced schoolteachers who taught a range of subjects, including MIB (Malay Islamic Monarchy), actively contributed to the expert group. By bringing together a diverse group of experts, the research was able to draw on a range of skills, knowledge, and experiences to create a curriculum that was engaging, innovative, and effective (Hamers et al. 2013).



Fig. 8 The expert group meeting was highly appreciated by all attendees for the efforts put into creating a climate change curriculum.

The expert group meeting aimed to achieve the following objectives:

1. To evaluate the development of a climate change curriculum that is appropriate for primary education in Brunei, and takes into account the explored ILK.
2. To review learning objectives and assessment indicators for the climate change curriculum, and ensure that they are aligned with the primary curriculum standards in Brunei.
3. To review the current primary curriculum in Brunei related to science, mathematics, ICT, English and Social Studies, and identify areas of overlap and potential gaps in coverage related to climate change education.

The expert group meeting was divided into two sessions – one in the morning and another in the afternoon. The group was comprised of subject matter experts from various fields, including university academics, curriculum specialists, educational researchers, and schoolteachers. In the morning session, university academics, curriculum specialists, and educational researchers discussed the learning objectives and integration of STEAM into each level of the climate change curriculum. During the afternoon session, the schoolteachers joined in and contributed to the evaluation of the curriculum. Most of experts' opinions were recorded through Mentimeter (<https://www.mentimeter.com>), an interactive presentation software that allows users to engage with their audience using real-time polls, quizzes, word clouds, Q&As, and other interactive features. Research assistants noted all comments and opinions made by the experts and displayed them on the Mentimeter. The contributions of each expert were highly valued, and they continued to collaborate throughout the research. The final proposed curriculum is presented in Table 7 and the suggested integration of ILK with the climate change curriculum is illustrated in Table 8.

The learning progression framework (Table 7) introduces children to climate change concepts from Year 1 to Year 6, gradually increasing in complexity. In Year 1, children begin by understanding hot and rainy days, their causes, effects such as droughts and floods, and basic solutions to mitigate these impacts. By Year 2, they explore weather changes and unpredictable patterns, learning ways to adapt. Year 3 focuses on human activities and their role in environmental issues like wildfires and floods, with strategies to reduce negative impacts. In Year 4, the curriculum addresses plastic use, emphasising its environmental harm and ways to minimise it. Year 5 covers how heat emissions from everyday activities contribute to global warming, leading to strategies to reduce these emissions. Finally, in Year 6, children learn about the overconsumption of resources, its link to global warming, and the promotion of sustainable practices within their communities.

Meanwhile, Table 8 outlines how ILK can be integrated into climate change curricula across various areas. The suggested curriculum integration is based on ILK identified in three indigenous communities during phase one of the research (see Table 6). Tables 7 and 8 are connected through their shared goal of integrating both climate science and ILK into the curriculum. Table 7 outlines a structured learning progression framework of the Climate Change Curriculum for Primary Schools in Brunei, focusing on the causes, effects, and mitigations and adaptations year by year. Table 8 complements this by suggesting practical, culturally relevant activities based on ILK, such as agriculture, foraging and hunting, fishing and river activities, household management, and business and economic activities. These ILK-based activities enrich the understanding of the concepts in Table 7, linking ILK with climate science and helping children explore local, sustainable practices that mitigate climate change.

Table 7 Learning progression framework of the Climate Change Curriculum for Primary Schools in Brunei.

	<i>Causes</i>	<i>Effects</i>	<i>Mitigations and Adaptations</i>
Year 1: Hot and rainy days	The differences between hot and rainy days	The causes and effects of droughts and flooding	Solutions to reduce the effects of droughts and flooding
Year 2: Weather changes	Weather changes, including hot and rainy seasons	The causes and effects of unpredictable weather	Ways to live and work in unpredictable weather
Year 3: Human activities	Human activities that contribute to weather changes	The impact of human activities on droughts, floods, landslides and wildfires	Strategies to reduce the impact of human activities on the environment
Year 4: The use of plastic	The effect of using plastic in everyday life	The impact of the use of plastic on the environment	Strategies to minimize the effect of plastic use on the environment
Year 5: Changing climate	The process of heat releases from everyday activities that affect the climate	The relationship between trapped heat processes and global warming	Environmental strategies to reduce heat emissions in everyday activities
Year 6: Sustainable practices	The impact of the over-consumption of resources and unsustainable practices on climate	The relationship between local practices and global warming	Strategies to promote sustainable practices among the community

Table 8 ILK and suggested curriculum activities in climate change.

<i>ILK</i>	<i>Suggested curriculum integration</i>
<i>Agriculture</i>	Introduce children to local agriculture and plant nurturing. A narrative should arouse curiosity about indigenous farming, leading to exploration. Use text excerpts to teach about indigenous farming, inspiring creative farm drawings. Then explore the impact of climate change with visuals and stories. Children should be encouraged to understand weather-related challenges, leading to farm adaptation scenarios. Drawings should depict indigenous practices amidst climate change.
<i>Foraging and hunting</i>	Familiarize children with community sustainability practices. Highlight the link between culture, tradition, and responsible food sourcing, emphasizing their role in climate education. Lessons should cover sustainable forest

	management, inherited skills, foraging, knowledge transmission, challenges, and climate connections. Encourage reflection on nature, sustainable food choices, and preserving traditions.
<i>Fishing and river activities</i>	Introduce children to the importance of aquatic ecosystems in communities, stressing rivers' role as vital habitats and sustenance sources for indigenous people. Address the impact of climate change on these ecosystems, encouraging children to protect habitats, practice sustainable fishing, and advocate for conservation. Foster a sense of stewardship, deepening children's understanding of community-environment-climate connections.
<i>Household management</i>	Use indigenous dishes to teach about the cultural and environmental aspects of cooking. Children should be encouraged to explore links between culinary methods, sustainability, and climate adaptation. Topics should include sustainable cooking with bamboo, local and seasonal foods' resilience, passing down culinary knowledge, and community bonding through shared traditions. Children should be able to understand how preserving foods supports heritage, resilience, and climate action.
<i>Business and economic activities</i>	Children should be encouraged to explore links between culture, the economy, and climate resilience. Lessons should include a discussion of sustainable agriculture, knowledge transfer across generations, cultural roles in biodiversity and climate adaptation, homestays, and adapting economies to changing climates. Overall, this curriculum aims to foster awareness of the complex ties between economic decisions, culture, and the environment, instilling a sense of responsibility for sustainable practices amid climate challenges.

8 Conclusions

This research, based on data from the STEMFunds project at Universiti Brunei Darussalam, provides valuable insights and recommendations for policymakers, academics, school leaders, teachers, children, and parents regarding the methods and processes involved in developing a culturally responsive and inclusive curriculum incorporating ILK for climate change education. The research presents an exemplar of a Climate Change Curriculum for Primary Schools, which can serve as a guide for curriculum specialists across Brunei. The research emphasized the importance of involving all stakeholders in the participatory, community-based curriculum development process. In particular, it highlighted the benefits of designing a curriculum that reflects ILK, specifically drawing from the indigenous communities in Temburong, Brunei, in this case. Ultimately, this research highlights the importance of incorporating ILK into a climate change curriculum in Brunei to ensure that it is not only educationally robust but also culturally relevant and responsive to local contexts. The curriculum can provide children with a deeper understanding of climate change impacts and adaptation strategies that are specific to Brunei's unique environmental and cultural landscape (Gupta et al. 2007).

As an immediate impact of the research, the STEMFunds project team was invited by the Department of Planning, Development, and Research, Ministry of Education, Brunei Darussalam, to present their research at the 'Coffee with DP' event on 5th June 2023. The event aimed to showcase the findings of the research and their implications for teaching and learning.

It was well attended by school leaders across Brunei, and the feedback was overwhelmingly positive. Some of the comments included: *“Congrats... it would be great to integrate this into the science curriculum and make climate change a school project,” “I agree that our science curriculum content needs to be updated to reflect the current situation,” “It would be beneficial to integrate climate change and related issues into the school curriculum,”* and *“Excellent! Well done... please continue this effort and expand it to the secondary level. The topic is timely and worth pursuing.”* Following the ‘Coffee with DP’ event, the team was invited to present the research to the policymakers on 13th June 2023 at Ministry of Education, Brunei Darussalam. The efforts in conducting this research were highly appreciated by the policymakers, and they congratulated the team. However, further research is needed to gather empirical evidence on the *effectiveness* of the developed curriculum framework among primary school children in Brunei, which highlights the limitations of this study.

Furthermore, this research showcases an example of the initiative to decolonize education, which refers to the process of dismantling the colonial legacy in education. This involves challenging dominant Eurocentric perspectives, privileging local and indigenous knowledge, and promoting diversity and inclusivity (Wimpenny et al. 2022), as well as re-examining the power dynamics and inequalities that shape the curriculum, teaching practices, and educational policies (Gibson and Farias 2020). Participatory, community-based curriculum development, which includes integrating ILK, is one approach that aligns with the principles of decolonizing education (Standley et al. 2022). By involving local communities, including indigenous communities, and those historically marginalized in the curriculum development process, it seeks to address the existing power imbalances and cultural biases that have shaped the curriculum (Alexander and Hjortsø 2019). Thus, this research aims to create a more inclusive and responsive climate change curriculum that reflects the diversity and richness of indigenous communities in Brunei (Taylor 2005).

The exemplar of the Climate Change Curriculum for Primary Schools presented in this research is an excellent example of how decolonizing education can be achieved by integrating ILK and values. This will ultimately help in creating an education system that values and celebrates cultural diversity and responsiveness and promotes inclusive and equitable learning environments for all children (Gibson and Farias 2020). The curriculum resonates significantly with the indigenous communities of Temburong, Brunei. Thus, it marks Universiti Brunei Darussalam’s significant contribution to climate change education and research. It signifies an important step in integrating academic expertise and resources to address environmental challenges (Leal Filho and Leal-Arcas 2019). Through this initiative, the university is not only advancing the scholarly understanding of climate change but also playing a pivotal role in developing educational content that has local impact and can be disseminated widely.

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