Cultural Studies of Science Education
https://doi.org/10.1007/s11422-025-10265-3

ORIGINAL PAPER

An exploration of Iban communities' indigenous funds of knowledge as an imperative resource for the STEAM curriculum-making process in Brunei Darussalam

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Received: 5 April 2024 / Accepted: 14 July 2025

Abstract
In colonial-based, mainstream educational systems, conventional teaching methods and curricula have been imposed on indigenous communities, often resulting in the neglect or devaluation of indigenous knowledge and ways of learning. This paper aims to explore the indigenous funds of knowledge of three Iban communities in Brunei Darussalam and to investigate the extent to which that knowledge can be utilized in the creation of a Science, Technology, Engineering, Arts and Mathematics (STEAM) curriculum. To explore the indigenous funds of knowledge, we collected qualitative data via 9 focus group interviews with 24 primary school children (aged 6 to 12 years old), with 2–3 children participating in each group, 6 household visits with 10 parents, 5 interviews with 7 teachers, and other ethnographic data collection methods. As a result, five indigenous funds of knowledge were identified: agricultural skills, foraging and hunting, fishing and river activities, household management, and business and economic activities. The study offers timely discussions regarding the importance of incorporating indigenous funds of knowledge into the STEAM curriculum-making process in the context of primary school syllabi and textbooks in Brunei Darussalam. The mapped out Iban funds of knowledge and the exemplar STEAM curriculum seek to facilitate primary school teachers, curriculum designers, teacher educators and academics in the integration of this knowledge within different school curriculum areas. This study provides a significant contribution to STEAM education and curriculum-making research by highlighting the importance of culturally relevant curricula for indigenous children and by offering a comprehensive practitioner-oriented approach.

Keywords Culturally relevant curriculum · Curriculum-making · Funds of knowledge · Indigenous knowledge · Primary STEAM

Lead editor: Rachel Gisewhite

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Introducing Iban language, identity and cultural heritage in Brunei

> "… Although the Ibans who reside in the village continue to maintain their cultural identity, the same cannot be said for their language. Over time, the linguistic identity of the Ibans has gradually diminished, particularly for those who reside in urban areas, as a result of the socialization process… It has been observed that Iban children in rural areas are accustomed to handling machetes and foraging, whereas those in urban areas who lack such experiences are often apprehensive and fearful of holding a machete or participating in traditional Iban activities, such as Iban *barik*." (Awang Hujan anak Muit, Kampung Amo, 10 November 2022)

To offer an entry point into this paper's key themes, we began with an anecdote from an interview with the head of Kampung Amo, who identified two distinct communities among the Iban peoples (henceforth Ibans) in Brunei Darussalam (henceforth Brunei). The two distinct groups are the Iban *rumah panjang* (literally translated as longhouse, henceforth rural people), who still reside in traditional longhouses, and the Iban *barik* (Iban terminology, henceforth urban people), who moved from their villages to live in urban areas in the nineteenth century in search of work. The village head explained that rural Ibans typically retain their linguistic identity, with the ability to communicate fluently in the Iban language. These individuals, found in the Temburong district of eastern Brunei (the location of the study), maintain their linguistic identity even when marrying Malay or Murut (another indigenous community in Brunei, also known as *Lun Bawang*) individuals or converting to the Islam religion (King and Knudsen 2021). In contrast, urban Ibans often lose their linguistic identity, struggling to speak the Iban language fluently. This loss can be attributed to various factors, including having a non-Iban parent (through mixed marriages), adopting the Malay language at home, or being immersed in a predominantly Malay-speaking community (Coluzzi 2010). For example, the second author of this paper, who has a mixed background of Iban, Murut, and Malay, admits to not speaking the Iban language and cannot understand it, due to their family's preference for speaking Malay at home. This language barrier has created difficulties when communicating with Iban relatives during family events and annual festivals.

The interview with the village head also emphasized the crucial role parents play in preserving the Iban linguistic identity among their children (Ting, Alvin and Jerome 2023), even for those living in urban areas. They cited instances where urban Iban children attending the Gawai festival—an annual celebration held on 1 June, marking the end of the rice harvesting season and serving as a day of thanksgiving—struggled to socialize with family members due to their limited understanding of the Iban language. Additionally, they noted that urban Ibans often lack traditional skills, such as farming, foraging, and handling machetes, unlike rural Ibans. The linguistic identity of urban Ibans will continue to diminish without proactive efforts from Iban communities to preserve their language and promote their culture (Coluzzi 2010). The village head advocated for a consistent promotion of the Iban language and culture beyond annual Gawai festivals and the integration of Iban culture into the school curriculum. Highlighting the literary prowess of the Ibans, as described by the international author, King and Knudsen (2021), they expressed the hope that an increased awareness would help preserve Ibans' rich cultural heritage. Yet, they also lamented the fact that young Ibans' ability to write poems and engage in other literary activities has waned in recent times. This decline is largely related to the failure to encourage a deeper connection between various Iban communities, with only a few individuals,

such as one of the former heads of an Iban community of Kampung Amo, still possessing such skills. They stressed the importance of revitalizing these traditions to ensure the continued preservation of the Iban language and culture for future generations (Coluzzi 2010). The interview with the head of the village served as a poignant reminder of the urgency and significance of our study. The gradual erosion of Iban linguistic identity, especially in urban areas, due to the socialization process, is a pressing concern (King and Knudsen 2021).

In this study, we argue that it is imperative to integrate indigenous knowledge into a Science, Technology, Engineering, Arts, and Mathematics (STEAM) curriculum in the context of primary school syllabi and textbooks (aged 6–12 years old) in Brunei. STEAM education can combine some or all disciplines of the above-mentioned subjects (Moore et al. 2014). In this study, we define STEAM as corresponding individual subjects offered in the primary curriculum in Brunei, including Science, Mathematics, Information and Communications Technology (ICT), Social Studies and English. The significance of a STEAM curriculum, as opposed to a STEM curriculum, lies in its capacity to merge indigenous knowledge with scientific and technological education, nurturing a more culturally inclusive, creative, and holistic learning experience for primary school children (Land 2013). To date, no STEAM curriculum has been developed in Brunei, thus offering the impetus for the current study's focus. Furthermore, teachers in Brunei, who are often at the forefront of shaping children's educational experiences, seem to overlook the significance of indigenous knowledge (Wood et al. 2022). We delve deeper into this observation in the following discussion, drawing insights from our interviews with Iban community members and educators from diverse global contexts. In the process, we home in on the multiple forms of knowledge Ibans possess, accumulated via cultural and historical transmission, otherwise known as funds of knowledge (Moll et al., 1992).

In the coming sections, we first discuss the untapped indigenous knowledge in existing primary curricula in Brunei and relate this topic to the STEAM curriculum-making process. We then describe the study and the methods it employed, before elaborating on the five identified funds of knowledge and offering some final discussions and conclusions. By mapping indigenous funds of knowledge, the paper seeks to contribute to the decolonization of knowledge.

Untapped indigenous knowledge in present primary curricula in Brunei

In recent years, science/STEAM education research has begun to recognize the value of incorporating indigenous knowledge into school curricula (Denton and Borrego 2021). However, our interviews with teachers revealed an unsettling trend: the glaring disconnect between Ibans' indigenous funds of knowledge and current primary school curricula in Brunei. The allure of teaching in remote areas of Brunei is undeniable; indeed, Temburong—the primary site of this research—hosts one of the best preserved rainforests in Borneo. Teachers who participated in our interviews were enveloped by nature, experiencing a stimulating environment and sense of belonging within a tight-knit community. Yet, their experiences were also layered with challenges. An interview with a British-born English teacher in a local school, specializing in early childhood education, offered insights into their experiences of teaching English as a second language in this distinctive locale. While they mentioned integrating local elements into the lesson planning, an example from the

interview reveals a potential oversight: they use English tales about tigers and discussions about snow in Britain as teaching tools. This suggests they might not be fully leveraging the local indigenous knowledge in their English instruction.

A similar observation has been made by Luis Moll and colleagues (1992), whose study explored the experiences of teachers who did not share the same cultural or socioeconomic background as their students; in resonance with data from the present study, the teachers often failed to recognize and incorporate the rich knowledge sources brought by the children into the classroom activities and pedagogical approaches employed. Thus, a discernible gap emerges between the abundance of indigenous knowledge and the educational experiences provided to the children. In response, the question that will drive this paper is: how can teachers bridge this gap to deliver a more comprehensive and culturally enriched learning experience? The interview with the English teacher was just one example of many where teachers were unlikely to acknowledge indigenous knowledge when creating educational curricula. Most teachers we interviewed were aware of the importance of cultural context in education; yet, while the approaches they employed were inclusive of global stories, they often overlooked the rich tapestry of local Iban tales and folklore. Integrating Iban stories into their work would not only demonstrate that they respect and acknowledge the community's rich cultural heritage, but would also make learning more relatable and engaging for the children (Hare 2012). A curriculum that marries both global and local narratives has the potential to create a more holistic and grounded educational experience (Osler 2015).

From our interviews, it became clear that many teachers, including those from abroad, have experienced only a limited immersion in the Iban community. This lack of deep engagement represents a missed opportunity to truly grasp the richness of local dialects and cultural expressions. Engaging directly with the community could foster a deeper understanding of these core areas, enabling teachers to communicate concepts in ways that resonate more profoundly with the children's cultural context (Llopart and Esteban-Guitart 2017). While certain teachers have commendably integrated elements of local knowledge, such as fishing, into their lessons, a more comprehensive exploration of Iban customs, traditions, and practices is warranted. This approach would seamlessly blend global concepts such as globalization with local realities, ensuring children are both engaged and receiving knowledge that reflects their lived experiences (Esteban-Guitart and Moll 2014). Moreover, we noticed that existing primary curricula in Brunei fail to integrate local and indigenous knowledge, particularly pertaining to the Ibans. A culturally informed curriculum should mirror the diverse experiences, histories, and knowledge of all its communities (Gay 2002). By foregrounding indigenous knowledge, in the study, we aim to craft an educational narrative that capitalizes on the depth and richness of local insights.

Existing curricula in Brunei appear to prioritize the future at the expense of the past (Sharbawi and Jaidin 2020). The indigenous knowledge of the Ibans is often overshadowed in the curriculum by global or Western-centric content and examples. It is vital that education in Brunei maintains a balance, ensuring children appreciate their roots while also preparing for a globalized future (Gaudelli 2014). In the drive to future-proof our children, the curriculum may be overlooking the present realities of the Ibans (Craft 2012). Introducing high-tech subjects like coding without addressing the basic infrastructural challenges of the community seems short-sighted. Furthermore, the Ibans' rich traditions and cultural elements such as dance and craft exemplify an art treasure trove waiting to be explored. By sidelining these traditional art forms in favor of more conventional arts, the curriculum deprives children of a holistic artistic education (Naughton et al. 2017). Incorporating indigenous arts could serve to enrich children's artistic experiences, promoting

cultural pride and diversity (Naughton et al. 2017). Language serves not just as a medium of instruction but as a cultural reservoir (Saussy 2017). Teaching Science in English might make pragmatic sense globally, but it serves to diminish the depth of indigenous knowledge that is tied to the native tongue. A balanced approach, incorporating both English and the native language, could ensure children receive a well-rounded education, rooted in their culture while being globally relevant (Rodriguez 2013).

In this discussion, we highlight a concerning oversight: teachers' potential underutilization of local indigenous knowledge. While some local elements find their way into the curriculum, the depth of Ibans' traditions, environment, and oral narratives may not be adequately captured. The rich tapestry of indigenous knowledge, essential for a comprehensive understanding of subjects like Science and Social Studies, is often side-lined in the current primary curriculum. Effectively leveraging this knowledge can provide children with a bridge between academic learning and their cultural heritage (Aikenhead and Ogawa 2007). This mirrors the earlier discussions in this paper, which highlighted that rural Ibans maintain their linguistic and cultural ties, in contrast to urban Ibans, who often drift from their linguistic roots due to immersion in Malay-speaking environments. The juxtaposition of rural Ibans' preservation of language and tradition and urban Ibans' corresponding struggles underscores the pressing need to incorporate Iban culture into education. Our preliminary observations in this paper underscore the motivation behind our study. Armed with these insights, we delve into the indigenous knowledge of Ibans in Brunei, aiming to discern how this knowledge can enrich a new primary STEAM curriculum.

Indigenous funds of knowledge and the STEAM curriculum-making process

Indigenous funds of knowledge and primary STEAM curricula can provide children with a holistic understanding of their environment and culture and can help to promote a sense of pride in and connection to their heritage (Denton and Borrego 2021). The phrase 'indigenous funds of knowledge' may be unclear or confusing to some practitioners, particularly teachers, as it is a relatively specialized term (Klenowski 2009). Indigenous knowledge refers to the traditional knowledge, practices, and beliefs of indigenous peoples, who are the original inhabitants of a particular region (Mahalik and Mahapatra 2010). The Ibans in Temburong, Brunei, have a rich and diverse cultural heritage, and their traditional knowledge encompasses various aspects of life, including ecological knowledge, traditional medicine, and cultural practices (King and Knudsen 2021). Meanwhile, funds of knowledge is an important approach that supports powerful learning outcomes, especially for indigenous children whose life experiences are not always valued in mainstream classroom environments (Andrews and Yee 2006).

Funds of knowledge was a term coined by Moll and colleagues (1992) to refer to the historically accumulated and culturally developed bodies of knowledge and skills essential for household and individual functioning and well-being. In the context of indigenous communities, knowledge and skills are associated with long histories of interaction with their natural surroundings, known as local ecological knowledge (Aswani et al. 2018). Therefore, in this paper, we conceptualize the term indigenous funds of knowledge as the utilization of the traditional knowledge, practices, and beliefs of indigenous peoples in the development of a culturally responsive curriculum. As mentioned above, this approach recognizes and values the unique knowledge systems of indigenous communities and seeks to

integrate them into the classroom (Coles-Ritchie and Charles 2011). Thus, in the process, the curriculum becomes more relevant and meaningful for indigenous children (Hickling-Hudson and Ahlquist 2003). It can also promote equity and justice in education by valuing the cultural heritage and knowledge of all children (Ladson-Billings 2014), and enhancing the cultural competency of teachers (Sleeter 2001).

In the literature, a number of studies have utilized indigenous funds of knowledge in the creation of a STEAM curriculum in diverse global contexts. Most of these studies explore the intersection of indigenous knowledge with contemporary educational frameworks, underscoring the importance of culturally relevant and inclusive teaching practices. Ron Eglash and colleagues (2020) take a critical stance on the conventional linear progression of Western STEAM models with African, African American, South American, and Native American educational communities. They argue for a more generative framework that incorporates indigenous knowledge systems, thereby advocating for a holistic and inclusive approach to STEAM education. This perspective is echoed by Angelina Castagno and colleagues (2022), who emphasize culturally responsive schooling in predominantly indigenous schools in the USA. In their study, they present tools for integrating indigenous perspectives into the curriculum, contributing significantly to the broader movement of decolonizing education (Burgess 2022). Meanwhile, the following studies provide practical examples of how indigenous and Western knowledge systems can be effectively combined. Amber Simpson and colleagues (2023) showcase a program that blends these perspectives within STEAM education in the USA, leading to children gaining a richer understanding of the subject. Similarly, Niken Wahyu Utami and colleagues (2021) explore the integration of Indonesian local knowledge into science education, demonstrating how indigenous knowledge can enrich and complement scientific concepts.

Julie Brown (2017) contributes to this discourse by integrating culturally responsive pedagogy with inquiry-based science education in a global context. Through a comprehensive metasynthesis, Brown highlights how these pedagogical approaches, when combined, can significantly enhance the educational experiences of children in K-12 settings, particularly in culturally diverse settings. The importance of integrating indigenous knowledge is also evident in specific subject areas like mathematics and environmental science. Miguel Licona's (2013) study with Mexican and Mexican–American families finds that families possess valuable and sophisticated knowledge that helps them navigate their daily lives. However, teachers often fail to recognize and utilize this knowledge to support immigrant children in science. On the other hand, Marta Civil (2016) investigates the application of indigenous knowledge in mathematics education in the USA, showing how it can provide a more engaging and culturally relevant approach to traditional approaches when teaching mathematical concepts. Karim-Aly Kassam and colleagues (2017) extend this perspective to environmental science in the contexts of the Lakota and Dakota communities, as well as rural New York states, underscoring the value of indigenous ecological knowledge in fostering a deeper understanding of environmental issues and stewardship. In another investigation of physics education, Roseleena Anantanukulwong and colleagues (2023) investigate the use of cultural artefacts in teaching physics in conflict-affected regions in Thailand. Their research highlights the role of cultural appreciation in enhancing student interest in physics, while also addressing broader socio-political issues.

The integration of indigenous funds of knowledge into the STEAM curriculum-making process, as evidenced by previous studies, enhances the learning experience for both indigenous and non-indigenous children and also plays a vital role in preserving indigenous cultural heritage. It is noteworthy that *none* of these studies, including our thorough literature search, have been conducted in Brunei or with Ibans in Borneo. This observation

underscores a significant research gap, highlighting the need for further study in this specific context.

Setting the scene: the Ibans of Temburong, Brunei

In this study, we explored the indigenous funds of knowledge of the Ibans residing in Temburong, Brunei. The Ibans, also known as Sea Dayaks, are a branch of the Dayak people on the island of Borneo. With a land mass of 743,330 km^2, Borneo is the third largest island in the world, and the largest in Asia; it is shared between Indonesia, Malaysia and Brunei (Tom Harrisson 1970). The origins, historical backgrounds and migrations of the Iban in Borneo have been extensively documented by historians and scholars (Sandin 1967). They are considered to be one of the first native groups to have inhabited Borneo. In the small sovereign state of Brunei (about one percent of Borneo's land area), the Iban are designated as indigenous under the Brunei Nationality Act 1961; however, they are not considered as one of the *puak jati* (translated as original tribes) of the state (Black 2011). Seven original tribes in Brunei Darussalam are recognized as a Malay race for the purposes of nationality, including Malay-Brunei, Dusun, Belait, Murut, Bisaya, Tutong and Kedayan. The Malay race is viewed as highly privileged in Brunei, as stated in Brunei Darussalam's Constitution of 1959 with Amendments in 2006. The reasons why the Iban were excluded from the seven original tribes remain unknown. Despite being a minority in Brunei, the Ibans have chosen to live in the Malay state. Although they enjoy some support and employment opportunities, they still do not have access to as many privileges or opportunities as other groups in Brunei (King and Knudsen 2021). Indeed, in Brunei, the Ibans are considered to be underprivileged communities. Although the government has put forward *no* formal identification system for underprivileged communities based on socioeconomic activities, this study has unearthed some evidence that supports the need for such an endeavor. First, as a result of not being recognized as one of the original tribes of Brunei, based on our interview data and information provided by our school partners, a large number of Ibans are still either stateless or hold permanent residencies (as they have Malaysian citizenship). Due to this, Iban children are mostly ineligible for school meals and bus transportation despite their family income being below average. Secondly, we found that the academic attainment of children from all three school partners was below average and some were unable to further their studies to secondary school level. Thirdly, participants (teachers) reported that the schools they work for receive less support and are involved in fewer educational initiatives led by the government and private sector because they are located in very remote districts. Therefore, Iban children do not have access to as many social and educational services as advantaged Malay communities. This study thus seeks to maximize the impacts for Iban children.

The Ibans in Brunei are located in two main districts, Temburong and Kuala Belait, as shown in Fig. 1. The two districts are separated by two other districts with a distance of 200 km. To minimize the logistical challenges of the study, we chose Temburong as our fieldwork and data collection site, as this district has the most Ibans and the team is located in the Brunei-Muara district. Temburong is a largely rural area of Brunei, which, before the opening of a new 30-km bridge at the beginning of the COVID-19 pandemic, was only accessible from the mainland by boat. The Ibans in Temburong are located in three main

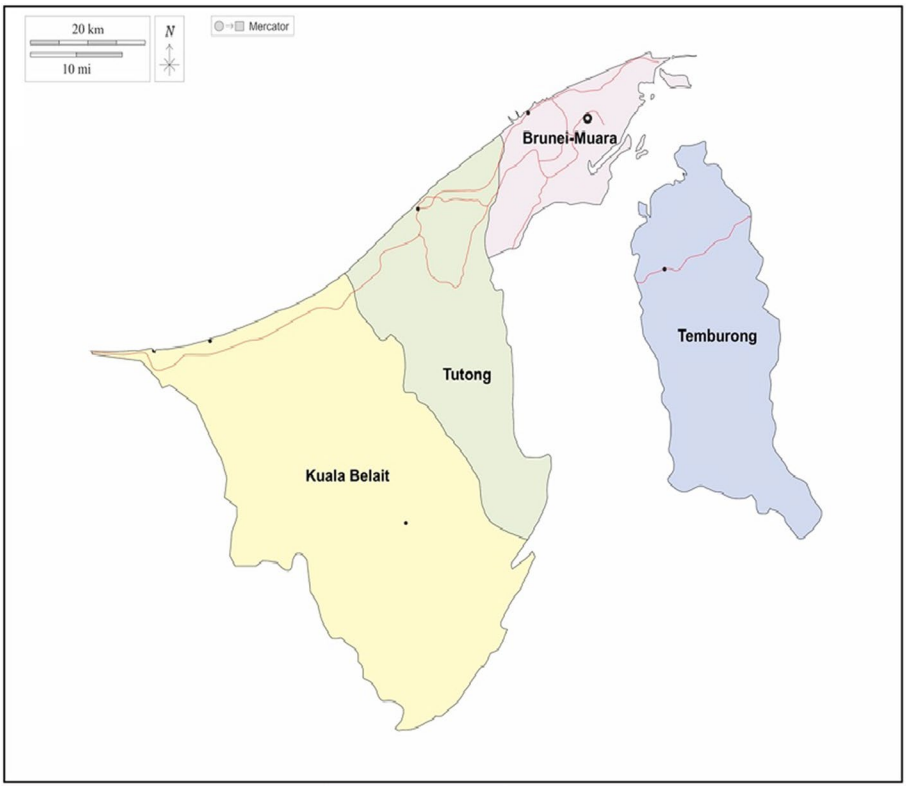

Fig. 1 Map of the four districts of Brunei, covering an area of 5,765 square kilometers

areas, and each of the communities has its own schools that provide primary education for Iban children.

Research question

How can teachers bridge the gap between the wealth of indigenous funds of knowledge and mainstream educational models to deliver a more comprehensive and culturally enriched learning experience?

Methods

Study design

This exploratory study is part of a larger piece of research that aims to identify the indigenous funds of knowledge of Ibans in Temburong, Brunei. In particular, it seeks to highlight the importance of this knowledge for STEAM curriculum-making practices. Before we commenced work on this study, we conceptualized it as being part of the reconnaissance

phase of the action research cycle, with the primary aim of surveying an area for practical or scientific purposes (Mat Noor 2022). The study employed a funds of knowledge approach to identify the knowledge and life experiences Iban community members possess, and to harness these elements as a powerful way of representing Iban people (González et al. 2005). An ethnographic data collection method we utilized was the household visit. This approach, which is key to the funds of knowledge approach, was particularly useful for exploring the culturally developed bodies of knowledge and skills of the Ibans. In this paper, we describe the Iban indigenous funds of knowledge that we identified and explored. We argue that those indigenous funds of knowledge are an imperative resource for the STEAM curriculum-making process, offering some possible suggestions for how they can be integrated into the STEAM curriculum in Brunei.

Ethical considerations

This exploratory study adhered to the ethical guidelines for conducting research in Brunei (2018). Given that the study involved the collection of personal information from young children, strict ethical procedures were implemented throughout the research process (Farrell 2005). The ethics of the study were thoroughly reviewed and approved by the ethics committee of the Sultan Hassanal Bolkiah Institute of Education, Universiti Brunei Darussalam (UBD) (reference number: UBD/SHBIE/D/F-16). In addition, we obtained permission from the Ministry of Education, Brunei, through the Department of Planning, Development and Research, to conduct the study with our school partners. At the outset of the study, we consulted with children, parents, and teachers from the three schools to obtain their consent to participate. All the participants we consulted with, including teachers, children, and parents from the three Iban communities, agreed to take part. They were provided with an information sheet and a consent form to sign. For the children, we explained the study in layman's terms and asked them to sign if they agreed to participate; we also consulted with their parents to obtain consent for their children's participation. All signed consent forms were collected (with the assistance of the teachers) and securely stored electronically with access restricted to only the research team members. The personal information and data collected in the study were kept confidential using password-encrypted files and will be retained only for the duration of the research period (the years 2022–2023).

Data collection and analysis

Data collection took place from 2 April 2022 to 20 March 2023. The lead author embarked on a camping trip to Ulu Temburong, a reserved forest area in Temburong, to gain firsthand experience of the ways of life of the Ibans. The campsite was run by Ibans, who fulfilled roles, such as business owners, forest rangers, cooks, and boatmen. While *no* formal data were collected during this camping trip, the lead author engaged in numerous conversations with Iban people, and captured their knowledge and insights through personal reflections. Subsequently, the lead and second authors visited a number of primary schools in Temburong to identify potential partners for the study. They identified three primary schools where a majority of children were Iban and approached the principals of these schools, who all agreed to participate in the study. With the assistance of the school principals, we conducted 9 focus group interviews with 24 children, with 2–3 children participating in each group, 6 household visits with 10 parents, and 5 interviews with 7 teachers, among other ethnographic data collection methods such as informal conversations,

visit, hiking and camping trips. All authors participated in the data collection period of the study. The qualitative data collected from the children, parents and teachers were analyzed using reflexive thematic analysis (Clarke and Braun 2021), to map out indigenous funds of knowledge with the Ibans. Codes were identified from the interview transcripts, and the funds of knowledge were categorized into themes. The codes and themes were validated through the use of a member-checking technique among researchers (Birt et al. 2016). In the subsequent discussions in this paper, we describe ways to incorporate the identified funds of knowledge into the primary STEAM curriculum in Brunei. The exemplar lesson planning illustrates suggested STEAM activities for each primary school level.

Findings

Indigenous funds of knowledge of the Ibans in Temburong, Brunei

Table 1 illustrates the various forms of indigenous knowledge identified among the Ibans of Temburong, Brunei. Based on thematic analysis (Clarke and Braun 2021), we classified this knowledge into five main categories: agricultural skills, foraging and hunting, fishing and river activities, household management, and business and economic activities.

Agricultural skills is the most significant indigenous fund of knowledge

Agricultural skills was found to be the most significant indigenous fund of knowledge among the Ibans. Historically, the Ibans are famous for their agricultural skills, including the cultivation of hill rice (Freeman 1955) and fruit orchards (Sait et al. 2018). We discovered that most Ibans engage in farming and gardening as part of their daily lives. While these activities are not pursued as full-time employment, mainly because production rates are inconsistent throughout the year and heavily influenced by weather conditions (Shams et al. 2015), the Ibans maintain them as vital parts of their heritage and traditions (King and Knudsen 2021). Based on the data, we differentiated between farming and gardening, as practiced by the Ibans. The majority of our participants referred to their agricultural activities as *berkebun*, which literally means gardening. All the Ibans we interviewed and visited engage in gardening; for instance, they cultivate vegetables and fruit trees around their houses for domestic consumption.

Sour eggplant (*Solanum lasiocarpum)* was a common sight in most house yards during our visits (see Fig. 2). During one visit, a participant explained that sour eggplant is a part of Ibans' identity, and it is also known as *terung Iban*, which literally means Ibans' eggplant.

The Temburong district experiences an equatorial climate influenced by the monsoon seasons, namely the northeast and southwest monsoons, which results in hot, wet conditions throughout the year. This climate contributes to distinct fruit seasons in the area. For instance, the durian (*Durio zibethinus L.*) season typically occurs between June and September, a period when Temburong receives less rain.

> "Gardening is a shared passion in our family. Our father-in-law practices it, and our sisters are also involved. When the crops thrive and the soil is fertile, we harvest produce, some of which is sold. For instance, we have harvested hundreds of bitter beans. There are two types: village bitter beans, which are tangy and spicy, and

Table 1 The five indigenous funds of knowledge of the Ibans in Temburong

Agriculture	Foraging and hunting
1. Farming/gardening skills: Using hoes; planting fruit and vegetables, flowers, and rice; watering plants; mowing grass 2. Construction skills: Building huts using *nipah* leaves, planting using hydroponics 3. Inherited farming/gardening skills: Learning farming/gardening from parents, slaughtering chickens 4. Part-time employment: Farmers/gardeners, lorry drivers/lawn mowers 5. Learning through farming/gardening: Co-curricular activities through Parent-Teacher Association (PTA), building hydroponics Types of fruit plants available in the area: Dragon fruit (*Selenicereus undatus*), rambutan (*Nephelium lappaceum*), pineapple (*Ananas comosus*), marang (*Artocarpus odoratissimus*), durian (*Durio zibethinus L.*), banana (*Musa acuminata*), cassava (*Manihot esculenta*), *kembayau/dabai* (*Canarium odontophyllum*), watermelon (*Citrullus lanatus*), papaya (*Carica papaya*), mango (*Mangifera indica*) Types of flower plants available in the area: Rose (*Rosa*), elephant ear/*keladi* (*Caladium*), jasmine (*Jasminum*), morning glory (*Ipomoea tricolor*), *bunga kertas* (*Bougainvillea*), West Indian jasmine (*Ixora*) Types of vegetable plants available in the area: Coconut shoot (*Cocos nucifera*), fiddlehead fern (*Diplazium esculentum*), water spinach (*Ipomoea aquatica*), bok choy (*Brassica rapa subsp. Chinensis*), mustard greens (*Brassica juncea L*), yardlong bean (*Vigna unguiculata ssp. Sesquipedalis*), cucumber (*Cucumis sativus*), bitter bean (*Parkia speciosa*), eggplant (*Solanum melongena*), sour eggplant (*Solanum lasiocarpum*), chili (*Capsicum annum L. or Capsicum frutescens L*), cassava shoot (*Manihot esculenta*), bamboo shoot (*Phyllostachys edulis*), rattan shoot (*Plectocomiopsis geminiflora*), *bagu* shoot (*Gnetum gnemon*), torch ginger shoot and flower (*Etlingera elatior*), turkey berry (*Solanum torvum)*, cherry tomatoes *(Solanum lycopersicum var. cerasiforme*), *jering* (*Archidendron pauciflorum*), a variety of wild mushrooms Types of rice farmed in the area: *Pusu* rice, *paya* rice, *laila* rice, red rice, *bario* rice, *kunyit* rice, *adan* rice, hill rice, oil *bandul* rice, garden rice, *antu* rice, a variety of seasonal rices	1. Foraging skills: Picking fruit and vegetables, gathering leaves for traditional foods like *kelupis*, cutting down bamboo, collecting rattan for crafting bubu, planting trees, cutting wooden twigs, creating entrances and paths within the forest, discovering new waterfalls, marking trees, identifying star fungi 2. Hunting skills: Trapping land animals such as deer, mouse deer, and wild boars, hunting birds and lizards using spears, fishing with trawlers 3. Tourism: Guiding forest exploration experiences, organizing forest picnics, conducting workshops on making machetes in longhouses, leading daily activities in hills and forests 4. Occupations: Forest police; tour guides; lorry drivers; catching and selling birds, including white-rumped shamas (*Copsychus malabaricus*), zebra doves (*Geopelia striata*), and quails 5. Community superstitions and practices regarding the forest: Wearing shirts inside out to prevent getting lost, avoiding fragrances when hunting deer, refraining from calling out names, prohibiting the uprooting of wood or twigs, keeping noise to a minimum, avoiding the removal of unfamiliar objects from the forest, not reacting to unusual smells or sounds Types of fruit collected in the forest: Durian (*Durio zibethinus L.),* rambutan (*Nephelium lappaceum*), marang (*Artocarpus odoratissimus*) Types of vegetables collected in the forest: Bamboo shoot (*Phyllostachys edulis*), coconut shoot (*Cocos nucifera*), cassava leaves (*Manihot esculenta*), fiddlehead fern (*Diplazium esculentum*), cassava (*Manihot esculenta*), rattan shoot (*Plectocomiopsis geminiflora*), bitter bean (*Parkia speciosa*), *jering* (*Archidendron pauciflorum*) Types of plant foraged in the forest: Phyrinium leaves (*Phacelophrynium Maximum*), pitcher plant (*Nepenthes*), *simpur* leaves (*Dillenia suffruticosa*), *lemba* leaves (*Molineria latifolia*), *kucai dayak* (*Allium cepa*), *bagu* shoot (*Gnetum gnemon*), a variety of leaves, tubers and shoots Types of animals hunted in the forest (for human consumption): Deer (*Cervidae*), white-rumped shama (*Copsychus malabaricus*), mouse deer (*Tragulidae*), pig-tailed macaque *(Macaca nemestrina),* hedgehog (*Erethizon dorsatum*), moonrat *(Echinosorex gymnura*), dhole (*Cuon alpinus*), sun bear (*Helarctos*), red junglefowl (*Gallus gallus*), wild boar (*Sus scrofa*), squirrel (*Sciuridae*)

Table 1 (continued)

Agriculture	Foraging and hunting
Fishing and river activities	***Household management***
1. Fishing processes/skills: Making fish traps; hooking giant freshwater prawns, utilizing fish traps, *rambat*, and trawlers; and techniques for using trawlers and hooks to catch fish 2. Inherited fishing skills: Learning from elders, traditional methods of making fish traps, self-taught techniques to craft fish traps for catching giant freshwater prawns 3. Household management: Preparing traditional meals/food, washing kitchen utensils in the river 4. Recreational activities: Going on fishing trips during weekends, bathing in natural waters, having picnics by the river 5. Part-time employment: Working as a fisherman, boatman, or tour guide 6. School activities: Learning about river ecosystems and their importance Types of bait used to catch giant freshwater prawn (*Macrobrachium rosenbergii*): Small shrimp, chicken liver, worms Types of fish available in the area: *Seluang* (*Rasbora spp.*), catfish (*Clarias spp. / Siluriformes*), river catfish (*Mystus baramensis*), giant freshwater prawn (*Macrobrachium rosenbergii*), freshwater crab (*Geothelphusa dehaani*), softshell turtle (*Trionychidae*), *salap* (*Barbonymus gonionotus*), *patin* (*Pangasius*), *semah* (*Tor*), milkfish (*Lactarius lactarius*), *puyu* (*Anabas testudineus*), *sepat* (*Trichogaster*), *kurau* (*Eleutheronema tetradactylum*)	1. Cooking skills: Specializing in preparing traditional dishes for festival events, especially for Gawai festival 2. Traditional or artisanal skills: Weaving, sewing, embroidering Iban methods of cooking: Stir-frying, smoking, using a firepit, frying, boiling, steaming, sautéing Iban traditional foods: Chicken/fish cooked in bamboo on an open fire pit, soy sauce chicken/snake/pig-tailed macaque, curry chicken, fried frog, marang stir fry, fried cicadas, fried grasshoppers, boiled cassava shoots, pickled fish, salted fish, fish ceviche, sun bear korma, boiled frog Iban traditional cakes/desserts: *Kuih jala* (lace pancake), *penyaram*, *kuih cacah*, *ketupat* (rice wrapped in woven palm leaves and then boiled), steamed glutinous rice, grilled glutinous rice, *wajik* Iban traditional snacks: Areca nuts, *sireh* leaves (*Piper betel*)
Business and economic activities	
1. Selling plants, animals, and traditional food: The Ibans participate in local markets, known as *tamu perayaan* or *nemuai* markets. They also sell a variety of plants, animals, and traditional Iban foods, within their communal longhouses, thus showcasing their agricultural and culinary skills 3. Creating and selling traditional Iban attire: The Ibans are known for their distinctive traditional attire, which they create and sell. These garments are often rich in cultural symbolism and are made using traditional methods and materials 4. Handcrafted bags, mats, and baskets: The Ibans are skilled in crafting various items such as bags, mats, and baskets, often using natural materials like rattan and bamboo. These handcrafted items reflect their intricate artistry and craftsmanship 5. Beaded flower making: The Ibans create intricate beaded flowers, a craft that requires a high degree of skill and patience. These beaded creations are highly valued for their aesthetic and cultural significance 6. Establishing homestays: In recent years, some Ibans have ventured into the tourism industry by establishing homestays. This allows them to share their rich cultural heritage and traditional lifestyle with visitors, while also providing an additional source of income	

Fig. 2 Ibans' sour eggplant was observed in most house yards during the visits

> agricultural bitter beans, which are milder. The seeds of the agricultural variety are imported from Thailand. The village bitter bean plants take a long time to bear fruit, sometimes not producing for over 10 years, while agricultural plants typically produce fruit within 5-6 years. Successful harvests hinge on soil fertility. Our younger brother has planted about 40 to 50 bitter bean trees, all fruitful. When it is not raining, the garden can be seen behind the car garage, located under the hill." (Roslind Rizawati anak Iqat, Kampung Semabat, 19 September, 2022)

During one visit, we interviewed a family who explained that they have a large area behind their house dedicated to gardening and farming. They mentioned that with luck, they could harvest more produce in certain seasons, like the durian season. When we inquired about what they meant by luck, they clarified that the produce heavily depends on the weather, and sudden changes can significantly affect crop yields. They further elaborated that consistent favorable weather conditions, including temperature, humidity, and rainfall, combined with fertile soil, are crucial for a bountiful harvest, an observation that is supported by Shahriar Shams and colleagues' (2015) agricultural study. The family also noted the importance of periodically using plant fertilizers, especially for fruit trees, as without them, the trees may not produce much fruit.

In addition, the family mentioned that another factor affecting production rates is the quality of seeds. They explained that imported seeds might have been genetically modified to create weather-resistant plants capable of producing results in a shorter time. For instance, the typical growth period for a bitter bean plant (*Parkia speciosa*) is around 10 years. However, with the new seeds sourced by the local agriculture department from Thailand, the plants can bear fruit within five to six years. Despite these different germination rates, the family can distinguish between the bitter beans grown from genetically modified seeds and those they traditionally forage from the forest. These plants naturally grow in lowland tropical forests, and their fruits are popular among Southeast Asian villagers

(Ghasemzadeh et al. 2018). Due to modern planting techniques, which lead to higher production volumes, the family is able to sell their produce in the local market once a season when the plants bear fruit.

Numerous agricultural stories shared by other Iban participants revealed a similar pattern. Firstly, the inherited knowledge of planting, encompassing both gardening and farming, is a primary reason why the Ibans continue to practice their agricultural traditions today. Secondly, indigenous knowledge regarding what, how, and when to plant is actively practiced, although it is gradually diminishing, particularly among the younger generation. Additionally, planting processes, significantly influenced by modern agricultural methods, determine whether the Ibans can still achieve substantial yields each year, which in turn contribute to their additional income.

Forest to table: using hunting and foraging skills to source food

The Ibans of Temburong engage in various foraging and hunting practices. Informal foraging often occurs individually or in small groups, similar to communal work during forest clearing for agricultural purposes. Traditionally, the Ibans have practiced sustainable forest management, preserving their culture, knowledge, and livelihoods in a way that does not compromise the forest ecosystems' ability to provide resources for future generations (Leo 2022). In modern times, sustainable forest management is regulated through government agencies. Two of the participants worked as forest rangers, responsible for patrolling and guarding the Temburong reserve forest and guiding visitors.

Most Ibans are skilled hunters and foragers, utilizing their inherited abilities for both personal consumption and commercial purposes. During the fieldwork, we asked the children if they had ever visited the forest. One child responded proudly, saying they had been to the forest with their family and learned how to forage for food in the nearby jungle, just like their father.

> "Yes, I have been to the forest with my father and mother. My father built a hut for us to relax in during our free time, and my mother planted flowers. She also planted fruit plants, such as bitter beans (*Parkia speciosa*). My father, sister, brother, and mother taught me how to plant fruits. We use the bitter bean seeds for my mother to sell. My father catches a pig-tailed macaque using a knife and makes snares with spikes. In addition to pig-tailed macaques, we catch fish, sea snails, and hornbills in the forest." (Azzieme anak Jem, Kampung Amo, 22 September, 2022)

The child shared that on one of the hunts, their father trapped a wild pig-tailed macaque *(Macaca nemestrina)* and used a knife to kill the animal. The pig-tailed macaque has light brown hair that covers its body and a white underbelly. The name originates from the unique morphology of its tail, which is short and carried half-erect so that it somewhat resembles a pig's tail (Choudhury 2003). Despite the fact that the pig-tailed macaque is now difficult to catch due to the reduced number available, the animal is still a favorite food and delicacy enjoyed by the Ibans (Parnwell and Bryant 1996).

In another interview, we discovered that the Ibans do not hunt animals randomly; they only select certain animals that can be consumed based on the inherited practices of their families, as these are the norms viewed at the societal level. Although the pig-tailed macaque resembles a monkey or orangutan, the Ibans do not consume these other animals due to their spiritual significance. The child also described how the mother cooked the pig-tailed macaque, using it in stir-fry or soup dishes. In Brunei, where

Muslims form the majority population, consuming these animals is prohibited under Islamic law (Razzak et al. 2015).

Hunting skills have become deeply embedded in the knowledge of the Ibans as they have been passed down to younger generations via ancestral traditions. Many of the interviewees took pride in sharing the ways Ibans hunted animals, such as mouse deer *(Tragulidae)*. Similar to the statistics related to pig-tailed macaques, the number of mouse deer in Temburong is decreasing, a trend that one of the village heads attributed to deforestation activities. Among the Ibans, mouse deer meat is famously used for human consumption (Wadley et al. 1997). The village head explained that the meat is versatile and can be cooked using various methods. For instance, it can be added to soup or curry dishes.

In another interview, a participant explained that they utilize hunting skills passed down through generations of their family to trap animals. Typically, these skills are demonstrated by the father, who often takes their children into the forest, if they are interested. The children learn these skills through observation, bypassing formal schooling. They are also able to distinguish between different animal species based on their morphological features. Some parents also still encourage their children to go out and explore the forest, hunting animals and foraging for food. The Ibans are especially well known for the foraging skills they use to acquire bamboo shoots, known as *umbut* or *upa* in the Iban language.

> "My child always follows me to the forest. Sometimes, my child goes fishing with me. We look for *umbut* in the forest... Mmm, bamboo shoots are from bamboo, while coconut shoots are from coconut and they have thorns. Both are delightful. *Umbut luba* has thorns as well. In the Iban language, we call *umbut luba* as coconut shoot or *upa*." (Muhammad Fauzi, Kampung Selapon, 20 September, 2022)

Bamboo plants grow rampantly and exhibit a variety of species (see Fig. 3). The participant mentioned that *umbut*, the edible shoots of bamboo, vary in size and flavor. For example, *umbut luba* (coconut shoot) is larger and has a bitter taste, whereas *umbut nibung*, *umbut pindang*, and *umbut piasau* (bamboo shoots) are sweeter. They also explained that there are some types of *umbut* that are inedible due to their poisonous nature. The skill of harvesting *umbut* is a form of ancestral knowledge. The participant emphasized their efforts to pass these skills on to their children, aiming to ensure that this knowledge is preserved for future generations. This is especially important given that *umbut* is an essential ingredient for creating a variety of Iban delicacies.

Despite the fact that utilizing hunting and foraging skills to source food is considered an important indigenous fund of knowledge among the Ibans, these practices rarely interest the younger generation. During many of our interviews and visits, we observed that nowadays, most children of the Iban community seldom enter the forests near their villages. They tend to spend most of their time at home playing video games just like urban children, as explained by mothers during household visits. In general, the number of Ibans who still practice these traditional activities is decreasing today. This was also evidenced in Victor King and Magne Knudsen's (2021) study, which found that Ibans were still actively involved in hunting, fishing and rice cultivation in Brunei up until the early 1980s. Afterward, these became part-time professions, being viewed merely as a source of food or income, due to declining interest among the younger generation, a result of both colonization and globalization (King and Knudsen 2021).

Fig. 3 Freshly foraged produce is sold at the Sunday market in the town of Temburong. 1 *Umbut luba* (*Bambusoideae*), 2 *Daun silat* (*Calathea lutea*), 3 – *Daun mudak* (*Nypa fruticans*)

Temburong is known as a key fishing spot for giant freshwater prawns

The rivers in Temburong are an important part of the district's ecology and provide a habitat for a variety of aquatic life. The main river, which runs through the heart of the district and is the main source of water for the local population, is Temburong river (see Fig. 4). The second river, Pandaruan river, shared between Brunei and Malaysia, is known for its scenic beauty, biodiversity and cultural significance. Both rivers provide an important source of food and livelihood for the Ibans and are home to a variety of fish species, including giant freshwater prawns (*Macrobrachium rosenbergii*). The prawns are known for their large size, with some specimens reaching up to 20 cm (8 inch.) in length. They have a distinctive brownish-green color, with long, slender bodies, and large claws. In Temburong, they are an important species for aquaculture, as they are highly valued for their delicious taste and texture, and can be caught in the wild (the price can range from around BND$20 to 30 per kilogram).

During a school visit, we conducted an interview with a school teacher who is known as a prawn fisher in the district. The teacher usually practices prawn fishing as a hobby on evenings and at weekends, which provides them with additional income. The participant inherited their fishing knowledge from the elders and practiced it over the course of years, developing prawn catching skills and gaining insights into the local geological areas. Their familiarity with the process of catching prawns, including techniques utilized and experiences related to fishing in the Temburong rivers, was evident during the interview.

> "To catch prawns, you need effective bait, which can include worms, small shrimp, or even chicken liver. After selecting your bait, you use a fishing rod with hooks

Fig. 4 The Temburong river is the only accessible route to the Ulu Temburong National Park, a reserved rainforest area

to catch the prawns one by one. Typically, multiple fishing rods are set up simultaneously, and then you wait. In Temburong and similar areas, prawns can be found in nearly every river. Interestingly, rivers with many crocodiles tend to have abundant prawns, possibly due to people being cautious about going near the water. As a result, the traditional method of using *bubu* to catch prawns is no longer common. In the past, people used to have up to 240 *bubu* traps and collect prawns weekly after leaving the traps in the river for a week. However, nowadays, giant freshwater prawns are becoming rarer. Previously, each *bubu* could yield 8-10 kilograms of prawns per week, but the current yield is significantly lower." (Saleh bin Haji Suboh, Kampung Semabat, 21 September, 2022)

The participant described the factors that influence prawn abundance in Temburong and similar areas. Studies about the abundance of prawns in Temburong can be traced back to 1987 (Thia-Eng et al. 1987), which reflects the richness of biodiversity in the river. These areas are well known for prawn fishing, and during the interview, the participant also made an interesting observation: rivers with a high crocodile population tend to have abundant prawns, possibly because people are cautious about approaching such waters. Hence, the participant mentioned that the traditional method of using *bubu* (fish traps) to catch prawns has become less common.

The utilization of *bubu* as fishing traps is a traditional method practiced among the Ibans; and they are very skilled in crafting *bubu*. They venture into forests to gather raw materials such as bamboo or rattan, which serve as the basis for making *bubu*. The *bubu* are then meticulously crafted by hand, using skills passed down from generation to generation. The use of *bubu* is not only an indigenous method practiced by the Ibans but also a

means to catch freshwater fishes. In a study conducted by Gary Loh Che Wyai and colleagues (2022), *bubu* was described as a source of pride for the Iban community. It served as a design probe for many studies, with the design concept originating from the Ibans.

In the same interview, the participant agreed that the indigenous funds of knowledge pertaining to fishing prawns and making *bubu* have potential value for learning and can thus be seen as an educational opportunity. However, when they were asked how they would integrate these forms of knowledge and skills into teaching and learning, they did not offer any viable solutions. The participant elaborated that the methods, knowledge, and skills associated with fishing for prawns and making *bubu* are not aligned with the curricula or subjects explicitly outlined in primary school syllabi and textbooks in Brunei. We can refer to this as one of a number of "missed learning opportunities" (Maynard and Waters 2007, p. 255), which aligns with the motivation behind our study, as discussed in the earlier part of this paper.

The emerging theme of fishing holds importance as part of the Ibans' indigenous funds of knowledge. The Ibans are well known for their high level of skill in fishing for prawns and crafting *bubu*. This inherited knowledge has been passed down through generations and still exists within their communities. However, the teacher we interviewed did not see the potential for incorporating this valuable knowledge into teaching and learning. Similar to the previous themes on agricultural skills, and foraging and hunting, practices such as fishing have not gained the attention of the younger generation, including children. Instead, these practices are often relegated to the realm of hobbies and supplementary income activities among the Ibans.

The rich tapestry of Iban culinary traditions and sustainability

Household management emerged as one of the key themes in our data, particularly in relation to cooking skills among the Ibans, as revealed through our interviews and visits. The Ibans possess local knowledge in preparing their traditional cuisine, which is generally simple and emphasizes the use of organic, natural ingredients (Keai et al. 2023). Traditional Iban dishes typically rely on basic ingredients like ginger, onion, and salt, in contrast to Malay cuisine, which is more complex and heavily influenced by a variety of spices (Emelia and Ramadhani 2021). The Ibans' diet is closely connected to the environment, with a deep understanding of the nature of their food, whether it is in the form of plants, fruits, or animal groups (Keai et al. 2023).

In one interview, a participant described *lulun*—meat cooked in bamboo—as one of the well-known traditional dishes that form a part of the Iban identity.

> "Sometimes, I make *lulun*, but not very often – only when I have ample time. For instance, during the last Gawai festival, which was six months ago, we cooked a lot of *lulun*. This is a traditional Iban dish that I usually prepare, along with others like cassava shoot mixed with torch ginger, and bamboo fish. For bamboo fish, we typically use freshwater fishes like silver catfish and rasbora fish, but catfish is also a common choice..." (Roslind Rizawati anak Iqat, Kampung Semabat, 19 September, 2022)

The participant described *lulun* as a traditional Iban dish and a staple during the Gawai festival. *Lulun* refers to the method of cooking food, typically a dish, in a bamboo tube. In a study on kitchen anthropology in Brunei, Faizul Ibrahim (2018) stated that the dish consists of pieces of chicken immersed in ginger and lemongrass, then packed into a bamboo

tube. This tube is secured with a banana leaf and set over an open pit fire for about an hour. In resonance with Ibrahim's study, the participant explained that the main ingredients for *lulun* could be either chicken or fish, all of which are cooked in a bamboo tube. The participant also confirmed that the method of cooking *lulun* has not undergone any changes and that the traditions have been maintained over generations.

Out of curiosity, we asked the Ibans to prepare *lulun* for us, as we were eager to experience this authentic dish (see Fig. 5). An Iban cook prepared two varieties of *lulun* using chicken and fish, elaborating on the distinct ingredients and methods used for each, which resulted in unique flavors and appearances. The chicken *lulun* incorporated lemongrass, cassava shoots, and torch ginger, while the fish *lulun* included turmeric, sour mangosteen, and torch ginger. These ingredient variations are reflective of the differing structures, textures, and flavors of the meats. The cooking method, which involves using a bamboo tube and an open pit fire, varies slightly between the two dishes in terms of timing, as fish cooks faster than chicken. The cook explained that cooking in a bamboo tube, sealed with cassava shoots, ensures that the meat remains tender and moist. Additionally, cooking over a fire pit imparts a subtle smoky flavor to the dishes. Consequently, each *lulun* dish boasts an aromatic and flavorful profile, setting it apart from other dishes in Brunei.

During another visit, a participant illustrated the preparation of various Iban traditional cakes and desserts like *penyaram*, *kuih jala*, *kuih cacah*, and *ketupat*. *Penyaram* is traditionally served during the Gawai festival and other Iban festivals. In traditional *penyaram* preparation, Ibans use a frying pan and firewood (Tugang et al. 2022). The participant noted that Ibans enjoy *penyaram* anytime, whether during the Gawai festival or as a regular treat, indicating that Iban cooking traditions and knowledge of making these delicacies are still very much alive. In addition, they expressed an intention to pass on the skills and

Fig. 5 Fish *lulun* was served during the curriculum focus group meeting on 22 February, 2023

knowledge of making *penyaram* to their children, ensuring the continuity of this culinary heritage.

> "Iban traditional delicacies, such as *penyaram*, are very popular. If there is an order, I'll make them and sell five pieces for $1. The ingredients include wheat flour, rice flour, and nipa palm sugar. The Iban communities especially love eating *penyaram* during the Gawai festival, when it is compulsory to have them. Other examples of traditional Iban food during the Gawai festival are *kuih jala*, *kuih cacah* and *ketupat*. We frequently make *ketupat* during both the Gawai festival and New Year. I also cook *lulun*, but like *penyaram*, *lulun* can be cooked on any day or time..." (Rabiatul Adawiyah binti Muhammad Isa, Kampung Semabat, 19 September 2022)

Although we have only demonstrated two popular culinary preparations among the Ibans, *lulun* and *penyaram*, our data revealed a similar pattern in household management. Firstly, traditionally, Iban households have been managed by women, a practice that continues today. Women, typically the mothers in Iban families, are in charge of food preparation, due to the men or fathers being occupied with full-time work. Secondly, as highlighted earlier, our study indicates that the younger generation is losing interest in traditional activities like agriculture, foraging, hunting, or fishing. In contrast, when it comes to Iban cuisine, a different trend can be observed. Most Ibans still consume traditional foods, and many are inclined toward learning to prepare Iban dishes. Finally, many Iban dishes utilize local resources rather than relying on imported ones, making use of ingredients found in the forest or around their homesteads. These practices exemplify how the Ibans are continuing to embrace sustainability.

Traditional economic activities among Iban communities

In previous discussions, we illustrated how Iban communities continue to harness their traditions and practices in agriculture, foraging, fishing, and cooking as hobbies, part-time employment, and sources of side income. Data from the study also highlight that economic activities, such as selling fruit and vegetables, are key for the Ibans. The Ibans typically harvest their own crops in house yard gardens or nearby forests, either for self-consumption or for selling to other villagers. During a household visit, a participant explained that on weekends, they take surplus products from the garden, such as cucumbers and cassava shoots, to a weekly market for sale. The income generated from these sales is used to purchase groceries for the family.

> "We obtain a small quantity of crops from our garden, and I sell these crops that I have personally planted at the local market every Sunday, including vegetables." (Lianawati Rioh, Kampung Amo, 10 November 2022)

On another household visit, the participant explained that they used to cultivate *sawi Iban*, also known as *ensabi* (*Brassica juncea*). However, they now frequently purchase vegetables from individuals who visit their home. They described how an elderly family member maintains a garden and engages in business-related activities on Sundays. The family member participates in a *nemuai* market, a market that used to be held on a weekly basis at an Iban longhouse, where people sold plants and produce from their gardens or the forest. However, since the COVID-19 pandemic, the market no longer runs weekly; instead, it operates whenever there is an abundance of produce

or demand from the community. There is also a weekly market held every Sunday in the nearby town, Temburong town (Kampung Puni) where the Ibans regularly engage in economic activities.

> "I have planted Iban mustard greens, but I often buy vegetables from people who come to my house to sell them. My mother has a garden, and they usually conduct business on Sundays. They sell their plants during the *nemuai* market, which my mother always participates in at the Iban longhouse. The *nemuai* market is typically held on Sundays, and while it is not a daily event, most people prefer this day. If a date is agreed upon, they advertise and invite people to the longhouse. We also have a homestay in Sibut village, which contributes to the longhouse community's income. My parents are still active in gardening, but I no longer engage in it myself." (Rosenitawati ank Ambar, Kampung Selapon, 20 September 2022)

During the interview, the participant mentioned that the family runs a homestay in Kampung Amo, thus generating employment and promoting economic development within the local longhouse community. It is open to anyone interested in experiencing Iban culture and their way of life, as stated by the participant. The participant also described that the charitable company established as part of the longhouse community brings together different families. They also frequently participate in festivals and exhibitions that celebrate local and traditional products, showcasing them for both national and international markets.

Our own observations during visits to markets and festivals in which Ibans participate provided further evidence of some evolving market trends. Interestingly, not all the products sold by Ibans at the markets or festivals originated from the local community or the Temburong district itself; some were imported from elsewhere. This has resulted in the commercialization of Iban markets. A notable shift in material choice has occurred, with *sikut*, traditional rattan or bamboo baskets being replaced by plastic alternatives (see Fig. 6). This transition is driven by the scarcity of materials from nearby forests. Plastic is now more accessible and cost-effective to produce compared to the increasingly rare rattan. A similar pattern has been reported by Asih Perwita Dewi and colleagues (2016) who found that the Ibans in Kalimantan Barat, Indonesia, could not access sufficient resources from plants to create craft materials due to deforestation. The decline in Iban production is also linked to decreasing production rates in Temburong, which primarily affects agriculture, foraging, hunting, and fishing, as we discussed earlier.

Village economic activities is a central theme of this study, representing an important indigenous fund of knowledge among the Ibans. Within this theme, the Ibans, particularly mothers and the elderly, continue these traditions, albeit on a part-time basis, as also evidenced in previous studies (King and Knudsen 2021). As discussed, a community within the longhouse has also established a charitable company, through which they sell various products. The Ibans have also ventured into hosting homestays, offering visitors a chance to experience Iban culture and traditions first-hand. While longhouses have evolved from traditional wooden structures into modern double-story brick buildings, the experiences they offer through tourism activities create opportunities for Ibans to share their traditions with other communities and pass this knowledge on to younger generations. Although these activities are pursued part-time, the participants emphasized that the younger generation could observe how tourism and other economic endeavors generate income while also preserving their cultural heritage.

Fig. 6 The plastic *sikut* (baskets) have become cheaper to produce and materials are more readily available

Reflecting on the indigenous funds of knowledge and development of a primary STEAM curriculum in Brunei

Although the Ibans possess significant skills, knowledge and practices, we found that in the current educational context in Brunei, this knowledge is unlikely to be integrated into a primary STEAM curriculum. From our document analyses of the syllabus and textbooks as well as multiple interviews and conversations with teachers from three Iban communities, it was observed that lamentably, the indigenous funds of knowledge are almost disregarded. Despite the fact that this study identified Iban communities' funds of knowledge, and we argue that they are extremely valuable for children, the teachers that we interviewed were unlikely to acknowledge these elements when teaching primary curricula. In the following, we provide possible suggestions with regards to the ways teachers, curriculum designers, teacher educators and academics can develop a STEAM lesson by interweaving the Iban indigenous funds of knowledge into its design and implementation. We have structured the suggestions on how to develop STEAM lessons from Year 1 to Year 6. Following the recommendation of Tamara Moore, et al. (2014) that the STEAM education approach can combine some or all disciplines of the relevant subjects, for each year we provide possible suggestions that integrate at least two to three STEAM subjects as part of the primary learning areas.

The STEAM curriculum for Year 1 children could integrate Science, ICT and English subjects. The lessons should be designed to teach about plant classification and the children should learn to identify and classify the main parts of local plants, such as sour eggplants, cucumbers, ensabi, and bamboo/rattan/coconut shoots. Using computers or tablets,

the children should be instructed to draw the seeds growing into plants, having observed this process in their gardens over time, and by also adding text to describe what is happening in each illustration. The suggested activity is similar to Anne Hickling and Susan Gelman's (1995) recommendation that children's early understanding of plant growth should be tapped into if they have grown up in an environment where they have already seen the process in action. Harnessing the illustrations they have chosen from their gardens, the children should then be asked to fill them in using a brush type and color of their choice. In addition, the teachers should provide a text from a local farmer that explains the process of planting local plants. By reading the text, the children should be instructed to identify new vocabulary such as stems, leaves, roots, flowers, fruits and seeds. The example we have illustrated shows the integration of the STEAM curriculum with an indigenous fund of knowledge: agricultural skills. Since children use their existing mental models to learn about plants, it is anticipated that the suggested lesson could increase children's interest and participation (Tunnicliffe and Reiss 2000).

For Year 2 children, a STEAM lesson could potentially integrate ICT, English and Mathematics subjects. Using the indigenous funds of knowledge of foraging and hunting, children could be facilitated to create interesting presentations and slideshows using computers or tablets through Microsoft PowerPoint. A particular topic they could explore is common wild animals and plants in their villages and nearby forests, such as *nyumbuh* (pig-tailed macaque) and bamboo/rattan/coconut shoots. The suggested activity is supported by studies which have found that the use of technologies in developing children's existing mental models and prior knowledge can foster their cognitive and conceptual development (Marhan et al. 2012). While the children create the presentations and slideshows, they should be encouraged to share their family stories regarding foraging, such as methods of trapping wild animals for food. The stories should be recorded by teachers in a comprehension text so that they can be used in English class. A similar pedagogy was used by Handayani (2013) who found that the use of children's own stories influenced the improvement of their reading comprehension. It is expected that the children may confidently strengthen their reading abilities and grasp the key details mentioned in a reading text in an English class by studying a comprehension text related to their funds of knowledge. As an extension to the suggested activity of foraging, the children may also learn about suitable timing for agriculture-related activities. Notably, with regards to calendar-related topics in Mathematics lessons, they could explore the process of planting produce such as *kunyit rice* and *adan rice* and harvesting them in local paddies. We have thus suggested the integration of these activities into the STEAM curriculum on the basis of another indigenous fund of knowledge: foraging.

Creating a STEAM curriculum for Year 3 children that incorporates Science, ICT, and Mathematics subjects could be an engaging and effective way to enhance their learning experience. Using the indigenous fund of knowledge of fishing and river activities from the Temburong areas, the children could be taught using Science to identify different animal species found in the rivers such as giant freshwater prawns (*Macrobrachium rosenbergii*), rasbora fish (*Rasbora* spp.), and soft-shell turtles (*Trionychidae*). These aquatic species are known by the Ibans, and children could be trained to use their local ecological knowledge to create dichotomous keys for identifying and classifying animals. A dichotomous key provides a structured way to present the user with pairs of contrasting statements (e.g., 'Has wings' vs. 'Does not have wings'), guiding them toward the accurate identification of organisms. The use of dichotomous keys has proven successful in previous studies for enabling students to gain an understanding of five distinct groups of animals: mammals, fish, birds, reptiles, and amphibians (Cascarosa et al. 2020). As children are familiar with

the species of animals that are commonly found in the local river, they can be facilitated to use a computer or tablet in ICT lessons to design sustainable fishing equipment such as fish traps (*bubu*), cast nets (*rambat*), and fishing nets (*pukat*). As an extension to the lessons, when the children are designing fishing traps, teachers should emphasize precise measurements with regards to height, width, and length as part of the Mathematics subject. The use of a sustainable fishing trap design as a teaching method may be unconventional for some teachers, but it has the potential to be an engaging and enjoyable learning experience for children, fostering a sense of environmental responsibility (Grammenos and Antona 2018).

A STEAM curriculum that promotes problem solving and critical thinking can be effectively integrated with other subjects, such as Science, Social Studies, English, and Mathematics. One example of this is in a Year 4 English class, where children could learn to write a local traditional recipe, such as *lulun* and *penyaram*, using appropriate vocabulary and local ingredients. Catherine Thomas (2014) suggests that teaching children using locally relevant authentic materials such as recipes facilitates opportunities to enhance children's skills in speaking, listening, reading, writing, grammar, and vocabulary activities. The tasks not only help children develop their basic language skills but also allow them to learn about the relevance of nutrients like protein, carbohydrates, vitamins, and minerals present in local foods, which is an important topic for a Science lesson. Additionally, when children are taught to write a local recipe, they will learn how to measure ingredients, which is an important skill in cooking, and a great way for children to practice mathematical concepts such as volume and fractions. Furthermore, learning about Social Studies will help children gain a better understanding of how humans meet their needs in a variety of ways, such as cooking for the family. This approach to teaching STEAM education through the lens of traditional and indigenous knowledge of household management, specifically cooking, is an engaging and meaningful way for children to learn and see the relevance of STEAM subjects in their everyday lives (Imaduddin et al. 2021). It also has the potential to spark their creativity, critical thinking and problem-solving skills, thus fostering a deeper connection with their community.

The Year 5 integrated STEAM lesson plan could intertwine Science, Social Studies, English, and ICT, laying a solid foundation for sustainable living and energy awareness through a range of activities. Children will uncover different sources of light energy and examine the significant effects of global warming, while also acquiring video-editing skills to craft compelling documentaries. English sessions will be designed to enhance presentation and writing capabilities, culminating in a cross-curricular documentary project that captures local environmental practices. The lesson references a study by Tasos Barbas et al. (2009), which found that both verbal and non-verbal nature documentaries enhance children's environmental sensitivity toward insects, with non-verbal formats also boosting knowledge and emotional connections. Furthermore, the curriculum encourages active participation in local agriculture, recognition of rivers' roles in indigenous cultures, and critical assessment of climate change impacts, thereby promoting stewardship and sustainability. Citing Paul Hart and Kathleen Nolan (1999), the approach is designed to help children value and maintain traditions, grasp the interplay between cultural practices, economic decisions, and environmental impacts, and develop a deep commitment to sustainable living and climate resilience.

To foster an environment for Year 6 children to explore, experiment and solve problems logically, a STEAM curriculum that incorporates Mathematics, Social Studies, and ICT may be developed. A key component of this curriculum could be linked to the business subject area, drawing on the funds of knowledge of the local community. In the Social Studies subject, children can learn about the importance of resources, specifically the use

of money. Teaching resources comprise an important aspect of the primary school curriculum as they help children appreciate the resources they have around them. In Brunei, the main sources of income are oil and gas, so it is essential for children to understand the value of these resources for the country's economy while also being critical of their role in environmental issues. Furthermore, this teaching approach could also prepare them to be future entrepreneurs. To provide hands-on learning experiences, teachers can organize an entrepreneurship day for children. This could involve activities such as selling local delicacies like *penyaram*, *kuih jala*, and others. Children could use calculators to solve problems more efficiently and make purchases more swiftly. Learning how to use calculators is part of the Mathematics lesson and not only involves basic mathematical skills but also entrepreneurship skills. As an extension to their entrepreneurship day activities, children could be taught how to create an online blog about their entrepreneurial activities. They could write their thoughts on the lessons learned and include images throughout the day. This could provide an opportunity for children to reflect on what they have learned and demonstrate their understanding of the concepts and skills introduced during the entrepreneurship day.

Discussion

At the beginning of this paper, we discussed the evolving dynamics of Iban language, identity, and cultural heritage in Brunei. We highlighted the challenges faced by the Ibans in preserving their language and traditional skills, notably migration to cities and globalization. The interview with the village head underscores the pressing issue of the erosion of linguistic identity, particularly among urban Ibans, due to socialization processes. This sets the stage for the significance of the present study, which aims to highlight the importance of indigenous knowledge in shaping an innovative STEAM curriculum within the primary school system in Brunei.

The difficulties encountered by the Ibans in preserving their language, identity, and cultural heritage, not only in Brunei but also in Borneo in general, including Malaysia and Indonesia, have been reported in various studies (King and Knudsen 2021). Salfarina Abdul Gapor and colleagues (2018) highlight the challenges faced by the Ibans in Sarawak, Malaysia, in preserving their traditional handicraft production amidst socioeconomic and environmental changes. These challenges include limited access to natural materials like rattan and bamboo due to deforestation, leading to a reliance on less sustainable materials such as plastic packaging strips. In addition, the younger generation has a lack of interest in continuing this tradition, and thus it is proving difficult to market their products. Similarly, Asih Perwita Dewi and colleagues (2016) report on the critical challenges faced by Ibans in Kalimantan Barat, Indonesia, chiefly due to deforestation, which is impacting the availability of traditional plant materials used in plaited crafts. This environmental issue is compounded by a decline in traditional crafting knowledge among younger generations, who show less interest in these cultural practices amidst modernization and technological changes. These examples highlight the challenges faced by the Ibans in Borneo, which are echoed in our study, demonstrating the difficulties in preserving their cultural heritage and handicraft traditions due to deforestation, modernization, and the declining interest among younger generations.

In our preliminary analysis, we examined the underutilization of indigenous knowledge, specifically within three Iban communities, in the context of the current primary curriculum in Brunei. It became apparent that a disconnect exists between the indigenous knowledge of the Ibans and the curriculum being taught in schools in Brunei. A similar pattern has been observed in many parts of the world where countries that were once colonized have been impacted by their colonial history, resulting in the disregard of indigenous knowledge within their education systems (Alejandra García Franco 2022). While some participants (teachers) in our study incorporate local elements into their teaching, there is a missed opportunity to fully harness the rich tapestry of Iban traditions, environmental approaches, and oral narratives in the curriculum. We advocate for a more balanced approach that both respects and acknowledges the cultural heritage of the Ibans while preparing children for a globalized future.

The central focus of this paper has been the importance of integrating indigenous knowledge into the curriculum to bridge the gap between academic learning and cultural heritage, particularly in STEAM subjects such as Science and Social Studies. The exploration of the Ibans' indigenous funds of knowledge resulted in five key themes: agricultural skills, foraging and hunting, fishing and river activities, household management, and business and economic activities. Agricultural skills stands out as a prominent form of knowledge, with hill rice cultivation and fruit orchards being historically significant. The Ibans rely on traditional farming and gardening practices, but modern methods and genetic modification are shaping their crop yields and income. With regards to hunting and foraging, they sustainably manage forest resources, capturing animals like pig-tailed macaques and mouse deer, as well as foraging for bamboo shoots. The rivers in Temburong are crucial for the Ibans, as they are home to giant freshwater prawns, but prawn yields have decreased over time. Traditional culinary traditions emphasize natural ingredients, with dishes like *lulun* and *penyaram* preserving their heritage. Traditional economic activities, including agriculture and tourism through homestays, continue as part-time endeavors, but changing market trends are impacting traditional production rates.

Overall, the Ibans are proud custodians of their indigenous funds of knowledge. However, the younger generation shows a declining interest in traditional practices. While these practices continue to be undertaken within the communities, they are now relegated largely to the realm of hobbies that bring in a side income. In a study conducted with the Ibans of Melilas Longhouse in Kuala Belait, Mahirah Nazatul Hazimah and Lian Kwen Fee (2023) reported that despite the fact that younger generation's formal education and qualifications are leading them to work in the government and the private sector rather than as rice farmers, they still maintain fluency in the Iban language, wear traditional Iban clothing, and celebrate Iban festivals. This contradicts the previous findings, which described the Iban language in Brunei as "endangered" (Coluzzi 2010, p. 119) and noted that "'traditional' Iban culture in Brunei has been lost, particularly religious beliefs, practices and livelihoods associated with the forests, the land and the rivers" (King and Knudsen 2021, p. 23). However, it is important to note that Mahirah Nazatul Hazimah and Lian Kwen Fee's (2023) study may represent a specific longhouse community and not necessarily the entire Iban population in Brunei. Throughout this study, elders have consistently encouraged the younger generation to remember their roots and uphold the Iban saying, *Agi idup agi ngelaban*, "as long as one lives, one will continue to fight, seek challenges, strive to achieve, and go all-out for improvements and overall success" (Low 2018, p. 421).

Conclusion

In this study, we have argued that there is an abundance of valuable resources within Iban communities' indigenous funds of knowledge, which can serve as valuable learning opportunities, both within and outside the Iban community. Therefore, we here summarize our suggestions for integrating these indigenous funds of knowledge into STEAM lessons for each year of primary education. For example, in Year 1, children can learn about plant classification and growth using local plants. Year 2 can involve creating presentations about wild animals and foraging practices, thus improving reading comprehension. Year 3 can focus on river ecosystems, animal identification, and sustainable fishing equipment design. Year 4 can include writing traditional recipes and learning about nutrition. In Year 5, children can learn about sustainable living and energy, through activities such as exploring light energy, examining global warming effects, and creating documentaries on environmental practices. Finally, Year 6 can incorporate business concepts, money management, entrepreneurship, and ICT skills through practical activities like an entrepreneurship day. These integrations aim to make STEAM education more engaging and relevant to children while preserving their cultural heritage and indigenous knowledge.

While our study has significantly contributed to the understanding of indigenous funds of knowledge among the Ibans in Brunei, it does have some limitations. It was conducted in Temburong, focusing on three Iban communities, with one community in a Kuala Belait district not included as the Temburong district has the most Ibans. Future studies should aim to encompass this missing perspective for a more comprehensive understanding. Despite these limitations, we have highlighted the richness of indigenous funds of knowledge among the Ibans in Temburong, suggesting that this knowledge is likely shared among Ibans in Malaysia and Indonesia, and should be recognized as an imperative resource for curriculum development in STEAM education (Khan and VanWynsberghe 2023). The mapped out indigenous funds of knowledge should be utilized by teachers, particularly school teachers in Temburong. Additionally, curriculum developers in Brunei should consider their integration to create tailored learning opportunities for children. For teacher educators, the study underscores the necessity to emphasize indigenous funds of knowledge in curriculum design when teaching pre- and in-service teacher education.

Prioritizing indigenous funds of knowledge in the curriculum has broader implications for the educational system, promoting the decolonization of knowledge, which is crucial for national stability (Burgess 2022). The significant contribution of the study lies in its scholarly mapping of indigenous funds of knowledge in the twenty-first century, emphasizing the importance of incorporating local and indigenous knowledge into STEAM curriculum-making process and learning opportunities. Practical examples have been provided in this paper to illustrate this integration, since empirical evidence and practical suggestions for effective implementation are currently lacking. The study advances traditional methodologies for understanding and utilizing indigenous funds of knowledge, anticipating further research and developments in this area to create a more inclusive and responsive curriculum.

Acknowledgements This paper is based on data collected as part of the STEM Funds project funded by Universiti Brunei Darussalam: 'Developing a Funds of Knowledge, Inquiry-Based Primary STEM Curriculum with Rural Communities in Brunei Darussalam: A Critical Participatory Action Research Study (Grant Number UBD/RSCH/1.7/FICBF(b)/2022/013). The authors also wish to acknowledge the contribution of the following partners involved in the data collection and analysis drawn on in this paper: Hardimah Mohd Said, Marlizayati Johari, Siti Aqilah Abdullah, Nyau Si Ting, Rouziyah Abu Bakar, Mohamad Firdaus

Mohd Aus and Ahmad Waridi Ahmad. We are also grateful to the teachers, children and parents from our partner schools and the Iban communities in Temburong, Brunei, who were involved in the STEM Funds project.

Author contributions This is a co-authored paper in which all authors conceptualized the paper, collected and analyzed data, and wrote up the ensuing outcomes collaboratively. All authors reviewed the manuscript.

Data availability No datasets were generated or analysed during the current study.

Declarations

Competing interests The authors declare no competing interests.

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