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Experiential learning of decolonial participatory design based on the Indigenous context of the Colombian Amazon

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ABSTRACT

While decolonial participatory design principles have gained attention in various fields, their specific application in international student exchange programmes has received limited scholarly attention. Recognising that Indigenous communities have long employed collaborative, community-based pedagogical approaches that embody these principles, this study examines how international exchange programmes can better integrate decolonial methodologies into their frameworks. We present a case study of four undergraduate engineering students participating in a participatory action research project focused on the intercultural health management of vector-borne diseases in the Colombian Amazon. Our methodology incorporates decolonial preparatory coursework, community-engaged fieldwork, and structured reflective practice workshops designed to support students in developing culturally responsive approaches to engineering challenges. By documenting the experiential learning process, implementation challenges, and outcomes of this exchange programme, this article provides insights for practitioners and educators seeking to transform international interchange experiences through more equitable, community-centred approaches.

KEYWORDS

Decolonising methods; Indigenous peoples; participatory action; intercultural; Amazon region

Introduction and context

Vector-borne diseases (VBDs) pose a significant challenge to public health. The Colombian Amazon is recognised as an endemic area for many of these diseases, particularly malaria and dengue (World Health Organization, 2020). In March 2023, the project 'Attention and care practices for the management of vector-borne diseases (VBDs) in the Southern Colombian Amazon' was developed through a collaborative alliance between the Tikuna Indigenous community of Puerto Esperanza, the One Health Consortium, and the Universidad Nacional de Colombia.

The community of Puerto Esperanza is located along the banks of the Amazon River, and its residents identify as members of the Tikuna people. While the community continues traditional subsistence activities such as fishing, hunting and farming, it has also expanded into various productive activities, primarily in tourism (Garzón,

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2022). The project aimed to design intercultural health strategies for managing VBDs by integrating Western medicine (biomedicine) and traditional medicine knowledge systems.

The educational partnership in intercultural engineering exchange

To strengthen the co-creation of VBDs' promotion and prevention activities with the community, the International Entrepreneurship & Development (IED) Minor Program at the Delft Centre for Entrepreneurship (DCE), Delft University of Technology (TU Delft), contributed to the project by facilitating the co-creation and adoption of a technological prototype for drying the bark necessary for VBDs' treatment.

The IED minor program is open to all undergraduate engineering students. It equips participants with the knowledge and competencies necessary to address complex socio-economic issues in developing and emerging economies through entrepreneurial approaches in the Global South and underrepresented sectors of the Global North.

The IED minor spans six months full-time and is structured in two phases. The first quarter comprises three integrated courses – Entrepreneurial Thinking, Preparations for Intercultural Research Projects, and Beyond Development: Pluriverse for Sustainability and Impact – that establish the theoretical and practical foundations for the subsequent study abroad module.

In the programme's second phase, the 15-ECTS Intercultural Integration Project takes engineering students to the Global South, where they implement their earlier project proposals. Working in cross-disciplinary teams, they partner with local communities and organisations to design and implement practical solutions that prioritise the co-development, co-creation, and co-design of technology-based entrepreneurship projects that address social, climate, and technological challenges in collaboration with Latin American, African, and Southeast Asian communities.

Pedagogical approach and study contribution

While conventional participatory design approaches aim to include end-users in decision-making processes, they often fail to adequately challenge the underlying colonial structures that privilege Western knowledge systems and marginalise Indigenous ways of knowing (Escobar, 2018; Smith et al., 2020). Preparing engineering students to engage respectfully and effectively with Indigenous communities requires fundamental shifts in understanding power dynamics and developing cultural competency, alongside collaborative design approaches that prioritise Indigenous sovereignty and knowledge systems.

As supervisors guiding international engineering students in intercultural contexts, we approached this work from distinct yet complementary positions that inform our decolonial pedagogical practice. The first supervisor, based in Colombia, focused on cultural preparation, facilitating community engagement protocols, and ensuring ethical reciprocity with Indigenous communities. The second supervisor, positioned within European academic institutions, provided critical perspectives on the power dynamics of international educational exchanges. Both supervisors addressed the complexities of North-

South academic collaborations by focusing on preparing students to critically examine their privileges and positionalities.

This article examines how international student exchange programmes can better integrate decolonial methodologies into their frameworks through a case study of four engineering students working with a Tikuna Indigenous community to develop a prototype for drying medicinal barks used in traditional vector-borne disease treatment. Our investigation focuses on how decolonial preparatory coursework, immersive fieldwork, and reflective practice workshops – informed by existing Indigenous collaborative educational practices – can enable students in conventional international exchange contexts to develop critical consciousness regarding colonial design practices while embracing genuinely collaborative approaches.

By documenting this experiential process within the framework of international student mobility, we offer insights into how established Indigenous educational methodologies might inform the restructuring of conventional exchange programmes. This research contributes practical methodologies for practitioners and educators seeking to implement decolonial approaches in international and intercultural educational settings, emphasising the importance of culturally sensitive, relevant, and sustainable solutions co-created with Indigenous communities.

Theoretical framework

Foundations of decolonial participatory design

Decolonising design offers a pathway to transformative and participatory design practices. This involves dismantling Western-centric foundations by situating and contextualising them within diverse cultural frameworks (Smith et al., 2020) and detaching from dominant systems that marginalise alternative knowledge systems (Schultz et al., 2018)

Relying solely on Western design methodologies disregards the rich epistemology and principles of colonised and marginalised communities worldwide. Escobar (2018) champions 'designing otherwise', advocating resistance to inherent biases, dismantling oppressive systems, and fostering ontologies that honour diverse human values and worldviews (Ansari, 2020; Leitão et al., 2021; Tunstall, 2013).

Research practices focused on decolonising design shift the emphasis from universalist knowledge creation to the contextualisation of diverse, historical, social, and culturally situated experiences and narratives (Ansari, 2020; Bidwell, 2016; Escobar, 2018; Smith et al., 2020; Winschiers-Theophilus & Bidwell, 2013). In Indigenous contexts, centring Indigenous worldviews and concerns by employing decolonial methodologies, methods, and theories is crucial (Smith, 2012).

Evolution and limitations of participatory design approaches

Participatory Design (PD) emerged in Scandinavia through collaborations between trade unionists and software developers. PD aims to redesign industrial processes, software interfaces, and workplace decision-making structures (Gregory, 2003), and involves end users throughout the process, seeking to empower them and build systems better suited to their needs. This approach has significantly influenced architecture, urban planning,

computer software, public services, communication infrastructure, and geographic information systems.

Participatory design processes sometimes provide legitimacy for pre-existing plans, often allowing a small group of participants to suggest minor modifications to processes and plans determined by incumbent powerholders. This dynamic perpetuates systemic oppression and reinforces existing inequalities (Fry, 2020; Schultz et al., 2018).

Centring Indigenous epistemologies in design practice

Integrating decolonial design perspectives into Indigenous contexts involves recognising and honouring traditional knowledge systems, cultural practices, and protocols. This approach necessitates the involvement of Indigenous peoples as co-researchers and co-creators to ensure that design solutions are relevant and empowering (Archibald, 2008; Berryman et al., 2017). Indigenous epistemologies emphasise interconnectedness, community well-being, and sustainability, which are crucial for addressing contemporary global challenges (Escobar, 2018; Smith, 2012).

Indigenous research paradigms are characterised by relational accountability, where knowledge is co-created through reciprocal relationships and shared responsibilities. Facilitating meaningful engagement with Indigenous communities requires a shift from extractive research practices to collaborative and empowering partnerships. Researchers must share power, acknowledge their positionality, and commit to long-term relationships based on trust and mutual respect (Grande, 2008; Smith, 2012).

Applying decolonial design in intercultural learning experiences

Decolonial design perspectives can be effectively applied to international intercultural learning experiences such as study abroad programmes and participatory action research (PAR) projects. These experiences offer students and researchers the opportunity to engage with Indigenous communities, learn from their knowledge systems, and co-create solutions that are culturally sensitive, relevant, and sustainable (Ahuriri-Driscoll et al., 2021; McNamara & Naepi, 2018).

PAR projects offer a framework for collaborative inquiry that involves community members as equal partners in the research process. This approach fosters a sense of ownership and empowerment among community members, leading to sustainable and impactful outcomes (Freire, 1972; Jemal, 2017). Intercultural learning experiences that prioritise decolonial design perspectives contribute to the development of students committed to social justice, equity, and environmental sustainability (Escobar, 2018; Smith, 2012).

Literature review

Decolonial theory and participatory design

Decolonial theory offers a crucial framework for examining the power dynamics and historical contexts that shape design practices. Mignolo and Walsh (2018) emphasised that decoloniality involves disengaging from colonial power structures and promoting

epistemic diversity. While participatory design ostensibly aligns with decolonial principles through its emphasis on democracy, mutual learning, and community empowerment, this intersection reveals significant tensions. Traditional participatory design approaches often maintain Western methodological foundations that inadvertently reproduce colonial power dynamics (Ehn et al., 2014; Tomasini Giannini & Mulder, 2022).

Tunstall (2013) argues that a truly decolonial participatory design must grapple with the ontological dimensions of Indigenous worldviews, acknowledging how colonial histories continue to shape present-day relationships, land connections, and knowledge systems. Consequently, decolonising curriculum and pedagogy within PAR projects demands a fundamental re-examination of positionality – of educators, students, and knowledge itself. This involves constructing inclusive curricula that privilege Indigenous knowledge systems, foster relational pedagogies rooted in reciprocity, and bridge academic institutions with community-led decolonial movements (Shahjahan et al., 2021).

Indigenous knowledge systems in interdisciplinary practice

Indigenous knowledge systems are holistic and interconnected, encompassing spiritual, cultural, and environmental dimensions. These systems provide valuable insights into sustainable and culturally relevant design practices. Integrating Indigenous knowledge into design requires respect for traditional protocols and valuing the contributions of Indigenous elders and community members (Berryman et al., 2017; Bon et al., 2022).

Beyond participatory design, interdisciplinary partnerships across the Amazon reveal diverse models of knowledge co-production in medical anthropology, ethnobotany, and intercultural health initiatives that demonstrate collaborative engagement with Indigenous communities while simultaneously developing frameworks that respect traditional knowledge systems.

Indigenous health agents exemplify collaborative practice as community members trained to bridge medical epistemologies while maintaining their cultural autonomy. Research on Munduruku community health workers in Brazil demonstrates how intercultural health agents navigate complex power dynamics between state biomedical services and traditional healing, consequently serving as intermediaries who transform both systems through 'creative intermediations' that generate new care practices (Gonçalves, 2022).

Brazilian medical anthropology has contributed significant theoretical and methodological innovations to understanding intercultural health collaborations, particularly through scholarship on therapeutic pluralism in Indigenous health policies. Moreover, this study develops critical perspectives on biomedical institutional engagement with Indigenous knowledge holders, especially regarding vector-borne diseases and Amazonian health challenges, thereby emphasising the importance of long-term relationships, cultural competency training, and institutional mechanisms that support Indigenous health governance.

Ethnobotanical work with Witoto communities on ash salt production in the Colombian Amazon exemplifies respectful knowledge co-production by documenting botanical species, chemical composition, and anthropological, nutritional, and cosmological significance within Witoto cultural systems (Echeverri & Román-Jitdutjaaño, 2011). Subsequently, this approach influenced work exploring how ash salt knowledge

represents environmental education within Witoto cosmology, thus demonstrating the interconnectedness of ecological, bodily, and cultural knowledge systems (Echeverri & Román-Jitdutjaaño, 2013).

Contemporary collaborative initiatives increasingly recognise that effective Indigenous partnerships require interdisciplinary teams working under Indigenous leadership, thereby supporting community-defined goals while generating knowledge that serves both local and global health needs (Vandebroek, 2013). Accordingly, integrating traditional medicine and biomedicine requires 'intercultural dialogue' moving beyond simple inclusion towards genuine epistemological exchange, which demands long-term commitment, community ownership, and recognition of Indigenous intellectual property rights.

Methods

The chosen methodology and methods represent a living process of constant improvement towards a dynamic decolonising approach. This fosters the co-creation of meaningful knowledge and enhances the visibility of Indigenous peoples' perspectives.

Participant selection and fieldwork

Four engineering students from the IED Minor Program at TU Delft were selected to co-create a prototype for drying medicinal barks. The Tikuna Indigenous communities traditionally prioritise these barks for treating vector-borne diseases (see Figure 1). The fieldwork spanned two months (November 2023–January 2024), during which the students actively participated in community activities, workshops, and prototype development.

Before fieldwork activities, we obtained formal authorisation from the traditional Indigenous authority of Puerto Esperanza (the 'Curaca'), recognised by the Colombian government under Law 270 of 1996. Community input shaped our research methodology through iterative consultation, with traditional healers maintaining decision-making

Figure 1. Prototype for drying medicinal barks for VBD treatment.

authority over medicinal bark selection and community members collectively determining material choices, construction methods, and testing procedures.

The traditional authority retained oversight with the power to modify or halt any research activities that were not aligned with community interests. Meanwhile, community members exercised full decision-making authority over the prototype specifications and construction processes. This governance structure ensured that Indigenous voices remained central throughout the research process, with the academic team serving a supporting rather than a leading role. This approach maintained respect for Indigenous governance protocols while ensuring community ownership of the process and its outcomes.

Both authors supervised the fieldwork to ensure adherence to established community decision-making protocols and guided the students in navigating the collaborative research framework.

Institutional partnership framework and academic supervision arrangements

The Universidad Nacional de Colombia served as the primary Colombian academic partner because of its established relationship with Indigenous communities in the region. The partnership with the IED Minor Program was strategically chosen to provide international engineering students with transformative learning experiences while ensuring that they were properly prepared through decolonial coursework delivered by a TU Delft supervisor.

Recognising the critical importance of cultural mediation and ethical engagement, a local supervisor from the Universidad Nacional de Colombia remained present with the students throughout their visit to Puerto Esperanza. This constant supervision was essential for facilitating appropriate intercultural dialogue with community members. Moreover, the supervisors' guidance served as a fundamental bridge between the students' academic backgrounds and the community's knowledge systems, preventing potential misunderstandings while ensuring respectful collaboration.

Practical framework for student engagement

A step-by-step methodology was developed to engage engineering students in decolonial participatory design (Figure 2). This process involved decolonial preparatory coursework, fieldwork, and reflective praxis workshops to immerse the students in Tikuna Indigenous knowledge systems and apply decolonial principles and practices in their interactions with the community.

The first step focused on setting the foundation by familiarising the engineering students with basic concepts to understand decolonial and participatory approaches. Before travelling to Colombia, between September and October 2023, they took the TU Delft course 'Beyond Development: Pluriverse for Sustainability & Impact' within the IED Minor Program to explore their reflexive skills and become more self-aware and sensitive to their system knowledge positionality, privileges, access power, and the historical, cultural, and biocultural richness of Indigenous people and local communities worldwide. Online coaching sessions complemented the course about the Colombian Amazonian

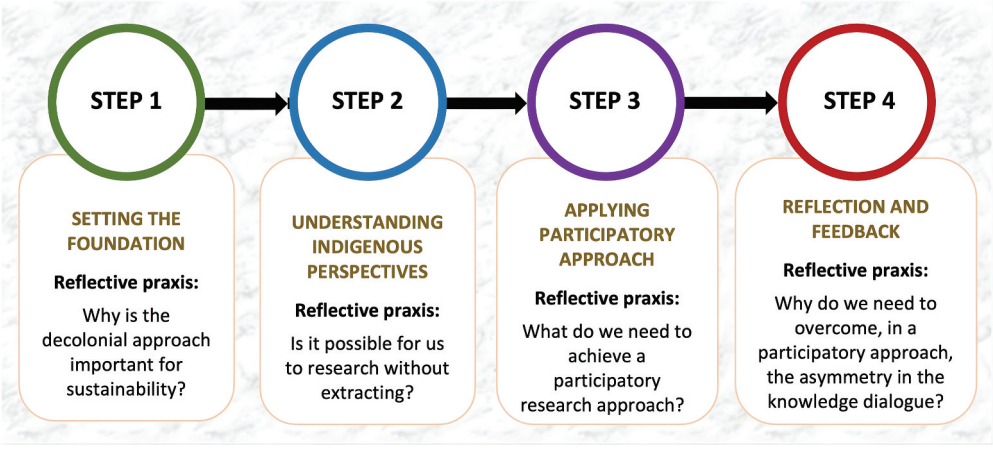

Figure 2. Step-by-step methodology to apply decolonial participatory design with the IED Minor Program students.

context given by one of the authors due to the expertise in Amazonia studies, human ecology, and ethnobotany. With this prior knowledge and preparation, the students travelled to Puerto Esperanza in November 2023 to interact with the local population for the first time.

After this fieldwork, they participated in December 2023 at the One Health Consortium workshop, 'Decolonial Participatory Design Perspectives with Indigenous Communities', which was developed in three in-person sessions with the online support of the IED Minor Program team professor, who is also one of the authors of this article.

In the framework of this workshop, the second step focused on understanding Indigenous perspectives. This session explored how to avoid critical practices such as academic extractivism through an understanding of cultural appropriation, the coloniality of knowledge, and the decolonisation of knowledge. This session highlighted practical examples from the context and worldview of the Indigenous peoples of the Colombian Amazon, including Indigenous forms of governance recognised by constitutional and legal frameworks, as well as laws and regulations governing the intellectual protection of traditional knowledge in Colombia.

In the third step, the students analysed the application of the PAR approach from a decolonial mindset, reflecting on the qualitative research they could apply in the specific context of the project, the fundamentals of PAR, and understanding the application of decolonial participatory design in a practical project on the Colombian Amazon. At this point, they analysed the expectations of the local people regarding the transformation of medicinal plants for VBD treatment and the foundations for elaborating a culturally, socially, and historically sensitive relevant prototype. The students also evaluated their proposed methods and whether those were accurate for co-creating a prototype that prioritises the community's needs.

The final step focused on reflective praxis and feedback on their co-creation activity, evaluating the experiences, challenges, and insights gained from their learning journey. In this session, we discussed the meaning of knowledge dialogue, the valorisation of traditional knowledge, and the Indigenous perspective on well-being, known as 'Buen Vivir'. In this step, students received feedback from supervisors and Indigenous collaborators before and after

the final fieldwork. This time was also relevant for reviewing the challenges in dialogue knowledge identified in Puerto Esperanza and how their perspectives on the decolonial design have evolved.

Data collection and analysis

At the end of each workshop session and upon the participants´ formal consent, reflection questions were conducted to confront the students about their ongoing learning experiences before, during, and after the fieldwork. The answers were discussed and reflected upon by conducting open workshop sessions, where concepts, keywords, individual reflections, group discussions, and reflections were enhanced and provoked. They also contributed a final report and a collective video as part of the assignments for the IED Minor Program, showcasing their learning experience.

While community members were active decision-makers throughout prototype development, our research design prioritised analysing student learning over comprehensively capturing Indigenous perspectives. The primary data sources – student reflections, workshop discussions, and academic reports – inherently focused only on academic perspectives. Consequently, community members' voices, decision-making processes, and experiences were documented primarily as they related to student learning outcomes.

A coding tree was developed to categorise the information obtained from the workshop and final report (Table 1), and the ATLAS.ti 24.1.1 software was used for the systematic analysis of the qualitative data gathered. Subsequently, descriptive statistics were used to quantify the data collected.

Results and discussion

Student awareness of colonial mindsets and Indigenous perspective

Knowledge colonisation is a complex and multifaceted issue with profound implications for various aspects of society. It refers to how dominant group knowledge systems, beliefs, and practices are imposed on marginalised communities (Levac et al., 2018). In the

Table 1. Coding tree for the analysis of qualitative data.

Codes	Subcodes
C1. Hegemony and colonisation of knowledge	SC1. Colonisation aspects identified before fieldwork
	SC2. Knowledge validation identified through fieldwork
	SC3. Potential colonialist practices in fieldwork
	SC4. Students' bias on fieldwork
	SC5. Colonialist legacy in Puerto Esperanza
C2. Application of a decolonial mindset in the fieldwork process	SC6. Effectiveness of qualitative applied methods
	SC7. Self-reflection of experiential learning
	SC8. Stakeholders recognised
	SC9. Community role based on a participatory approach
	SC10. Students' role in the co-creation process
	SC11. A decolonial perspective of traditional knowledge
C3. Students' insights into the impacts of the prototype co-creation	SC12. Social impact to achieve
	SC13. Sustainable impact to achieve
	SC14. Challenges in dialogue knowledge

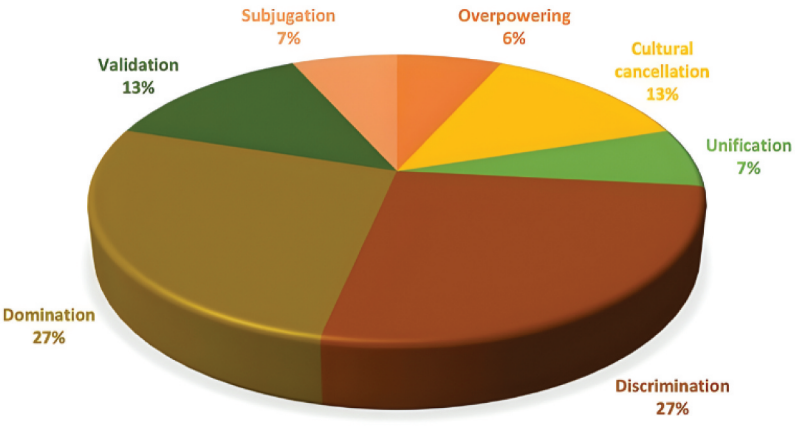

Figure 3. Frequency of keywords related to the coloniality of knowledge meaning.

reflection praxis for understanding the Indigenous perspective, the students identified two main concepts related to potential colonialist aspects before fieldwork: domination and discrimination (Figure 3).

At the beginning of the prototype design process in the Netherlands, community involvement and participation were limited. Therefore, the students prioritised their ideas based solely on their academic knowledge and Eurocentric perspectives. In this initial scenario, they disregarded local people's practices and understanding because they assumed that an engineering-solution mindset approach was sufficient for the prototype and that their design could be adapted to any context.

Initially, the students' concept of co-creation was unclear, and the local people's involvement was considered secondary, rather than an active role in the prototyping design. Additionally, they assumed the idea of having a way of contact with the community, even if they were not physically present; however, this assumption was proven wrong once they arrived in Colombia and reviewed the communication protocols according to Tikuna Indigenous perspectives and practices. As the students recognised, having only a Western mindset led them to believe that their objective knowledge was unique and universally valid. Therefore, they did not fully consider the community's traditions, expectations, and needs.

Based on this premise, validation has been identified as a potential colonialist practice in the fieldwork. In this practice, the dominance of Western epistemological frameworks in the pursuit of truth and accuracy has influenced the rationalisation of knowledge from other systems, often relegating them to marginalised or subordinate sources of information (Omodan, 2024). Moreover, the students were aware of cultural cancellation as another main bias due to the disqualification of traditional knowledge in addressing local problems related to vector-borne diseases.

According to Chambers (2020), Eurocentric constructions are rooted in a sense of superiority, leading to the marginalisation and discrimination of those who do not conform to the dominant worldview. This discrimination is also used to label traditional knowledge as backward, savage, and irreconcilable with progress (Santiago, 2012). In

the reflection praxis, the students concluded that the existence of colonial aspects and biases at the beginning of the design process was unintentional, and they became aware of these due to the foundations and Indigenous context-based workshop sessions with the supervision team.

In a practical sense, rethinking colonialism and understanding the Indigenous context, the students analysed some elements of the colonialist legacy after their first interaction with the community. Even though the Amazon Indigenous people are striving to preserve their traditional practices and languages, the impact of colonialist practices in the local context was evident for the students through primary elements such as the Spanish language and religion.

Although Puerto Esperanza is recognised as part of the Tikuna people, their language is not widely practiced by the majority of the population (Garzón, 2022). Consequently, the Tikuna language and cosmovision are not equally embedded in the community as other elements of the remaining hegemonic culture are. For the students, this colonialist practice had a profound impact on their activities. Through their dialogue with community members, one student noted: 'as words originating from their traditional Tikuna language hold deep spiritual meanings that cannot possibly be translated into Spanish'.

Other aspects, such as cultural appropriation, educational imposition, and loss of territorial connection, were observed during their experiential learning in the Southern Amazon. The students became more aware of the need to respect Tikuna names and practices in commercial settings without authorisation, thereby excluding their cultural contexts. Through dialogue, they could connect more deeply with some members of the community and realise other social issues:

> We can see that younger people are unaware of their traditional knowledge, which is not being taught in schools, and this also worries the older adults in the community. They were being taught their own culture instead of being taught other things that were not as useful in the community.

Applying a participatory approach and a decolonial mindset in the prototype co-creation

The students created a mind map presenting their main topics throughout the IED Minor Program to achieve a decolonial mindset and an unbiased co-creation process (Figure 4). This map reflects their commitment to a participatory approach based on ongoing dialogue, collaborative learning, and integrating diverse perspectives for respectful engagement with the community. For them, the process started with the foundations of decoloniality provided in the 'Beyond Development: Pluriverse for Sustainability & Impact' course, which gave them a new perspective on learning decolonial principles, theories, and practices.

On the second topic of participatory design, the students considered that one of the main foundations for shifting to a decolonial mindset was complemented by the workshop session related to the PAR approach and qualitative methods. According to Cornish et al. (2023), PAR is an important emancipatory form of scholarship to overcome objectivity and neutrality. Based on the principles of decoloniality, PAR advocates a model of inclusivity and collaboration among all stakeholders, ensuring that every voice is

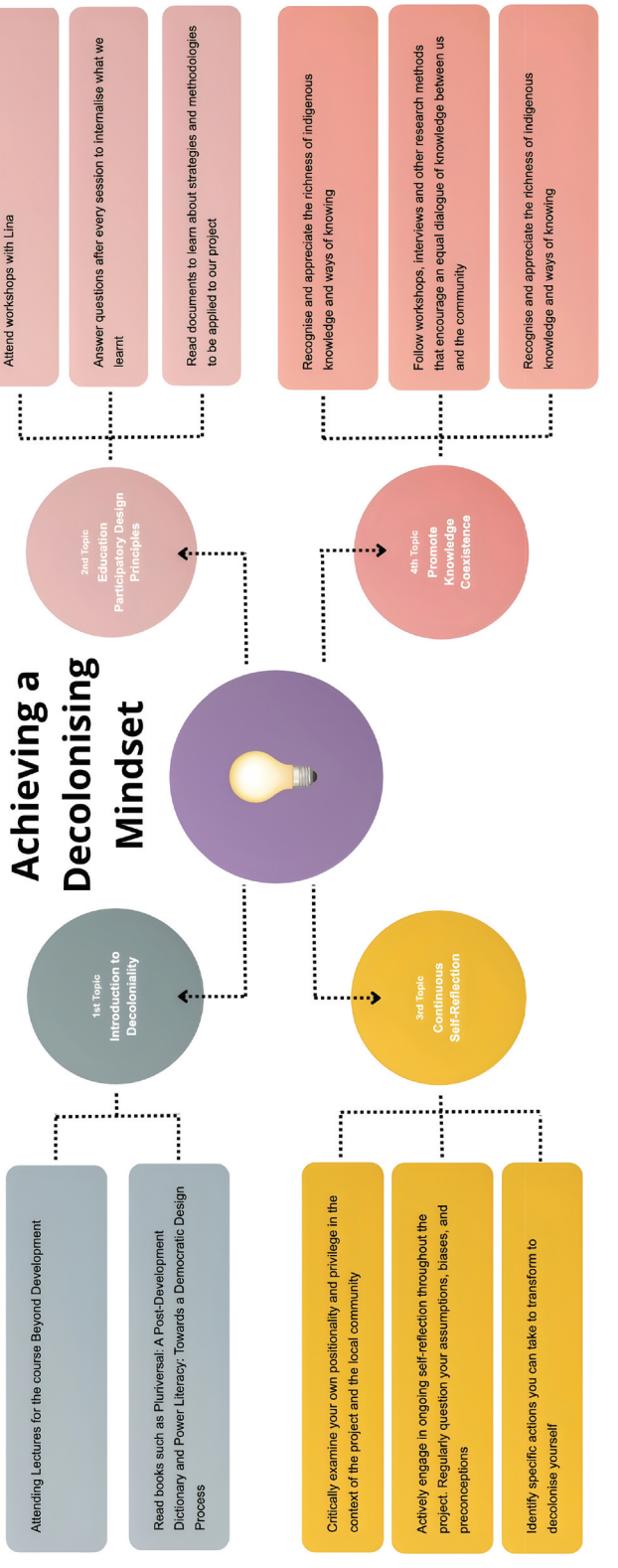

Figure 4. Students' mind map to achieve a decolonial mindset.

acknowledged without bias, thereby facilitating the development of responsive and practical solutions (Omodan & Dastile, 2023).

The students self-reflected on the evolution of the methodological approach throughout the two fieldworks. They employed interviews and workshops as qualitative methods for the prototype design and received ongoing support from the project team to refine the questions before interacting with the community. During fieldwork, they received guidance from the team project to enhance their participatory skills, as they lacked experience working with Indigenous communities and faced language barriers.

During the self-reflection process, the students realised that their initial research approach was focused on implementing their ideas in the prototype creation and using local knowledge as additional information, instead of incorporating the community's knowledge and active participation in local materials and building skills as their primary source of information and their engineering/design expertise as a complementary source of knowledge and practice. Despite the challenges of fieldwork, the students became more aware of the relevance of including the viewpoints of Indigenous people and being open to the active role of Tikuna community members from Puerto Esperanza in the solutions for drying, grinding, and storing the product in airtight places.

Throughout the second fieldwork and the building of the prototype, their research approach changed; they expressed the following:

> 'It became more human-centred, more back and forth, and took on a more background role, instead of being upfront and asking them directly'.

The way the students understood the possible motivations of the community to keep using the drying prototype after the project ended was by creating safe spaces where the people from the community could dialogue and intervene during the co-design process. They observed and questioned it, and by actively appreciating and incorporating the feedback given by the community in every step of the design process, they gained a sense of what they were told (Figure 5).

The decolonising mindset process continued with the third topic: self-reflection. The reflection praxis was meaningful because it reinforced the discussion and reflection on how their privilege and access to power might influence the co-creation process, both individually and as a team. Likewise, they also explored the stakeholders involved in this process and the community's role.

The students identified six stakeholders involved in prototype co-creation (Figure 6). They recognised the traditional authority (Curaca) as 'a vital bridge influencing their collaboration with the community' because of her influence in promoting project activities and maintaining a fluent dialogue with the local population. In a personal interview with the Curaca, they recognised her respect for the community's opinions and commitment to a consensus-based decision-making process.

The health promoter of Puerto Esperanza is an Indigenous resident and a functionary of the Secretaría Departamental de Salud de Amazonas (Amazon Departmental Secretary of Health). His work extends beyond the Ministry of Health's surveillance guidelines in his community and nearby communities. He also supports activities from other state programmes and research projects related to traditional and Western medicines (Garzón, 2022).

Figure 5. Student-community collaboration in the participatory design process. A. Dialogue with traditional healers to prioritise medicinal plants for bark extraction. B. Prototype building process with local materials. C. Test for bark pulverisation with community members.

Based on his work, the students worked alongside the health promoter leader to ensure active community engagement, thanks to his active role as a link between traditional healers and the entire team in the field, including the project members and students. His contribution and active involvement were crucial for addressing the value and acceptance of the VBDs project and the long-term use of the prototype. Moreover, healers were fundamental in prioritising bark identification for the treatment of VBDs and in the relevance of incorporating the prototype into medical practice.

The project articulation and IED Minor Program supervisors played a crucial role in guiding the students within the community and ensuring that the agreements established with the traditional authority at the project's inception were fulfilled. Outside the community, the supervisors helped them through each step of the methodology for applying a decolonial perspective to the prototype design. As students said, 'They helped us modify our mindset into a decolonised one'.

Community-led involvement was vital for the students because their authentic perspective guided and enriched the solutions to the co-creation challenge, strengthening a collaborative environment for community-driven success in Puerto Esperanza. Consequently, the students became aware that the community was the primary

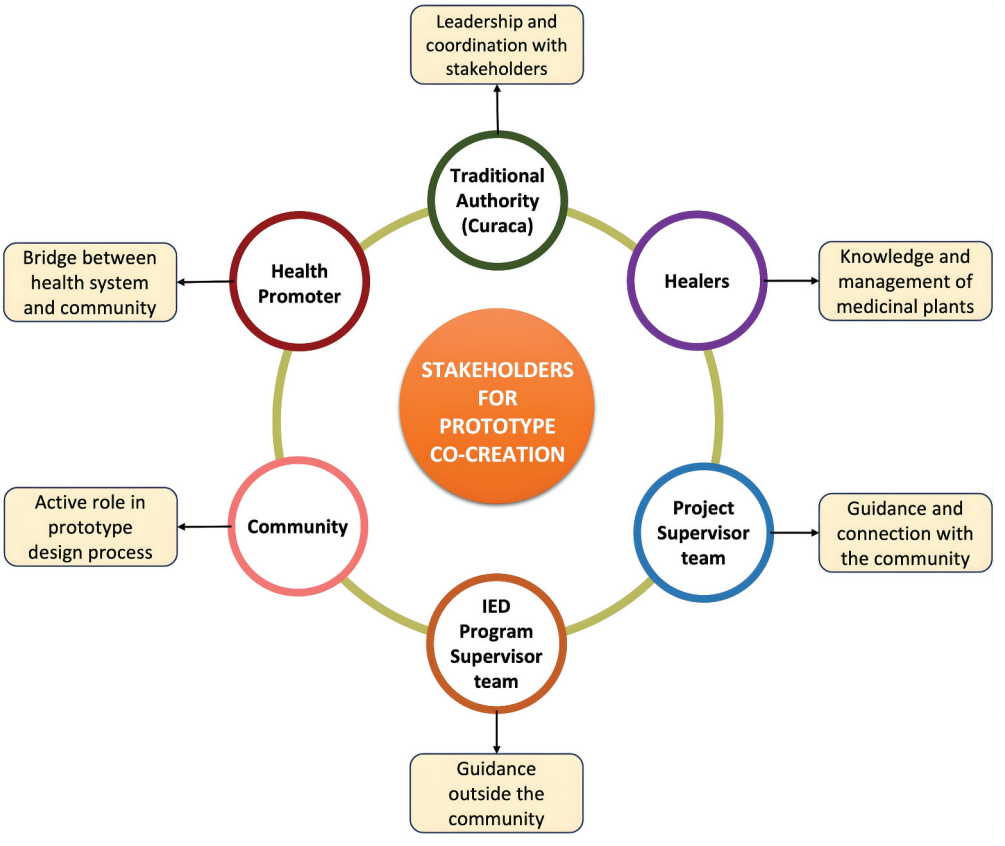

Figure 6. Stakeholders recognised for the prototype co-creation.

stakeholder and decision maker. This role awareness means that the community should always have the primary voice in the design process, building process, and future applications of the prototype in intercultural healthcare treatments.

The fourth topic, knowledge coexistence, was recognised as a means of achieving a decolonised mindset. Based on the designer role categories of Tomasini Giannini and Mulder (2022), the students evaluated the evolution of their roles throughout the experiential learning process for the power-balanced participatory design process (Figure 7). At the beginning of the process, they recognised themselves as ego-designers, with significantly more control over decision-making and complete control over the prototype design, without any contact with local people. Consequently, the community power was the lowest.

Over time, during the fieldwork, they evolved their role as facilitators, involving healers and other community members with leadership and experience in skill building and construction. The dialogue space held in the Maloca (traditional house) and interviews were crucial to understanding how they would invest their knowledge in the project to achieve sustainability. They were eager to participate and build the prototype. Although the students still had higher control over the process, community participation and power in prototype co-creation increased.

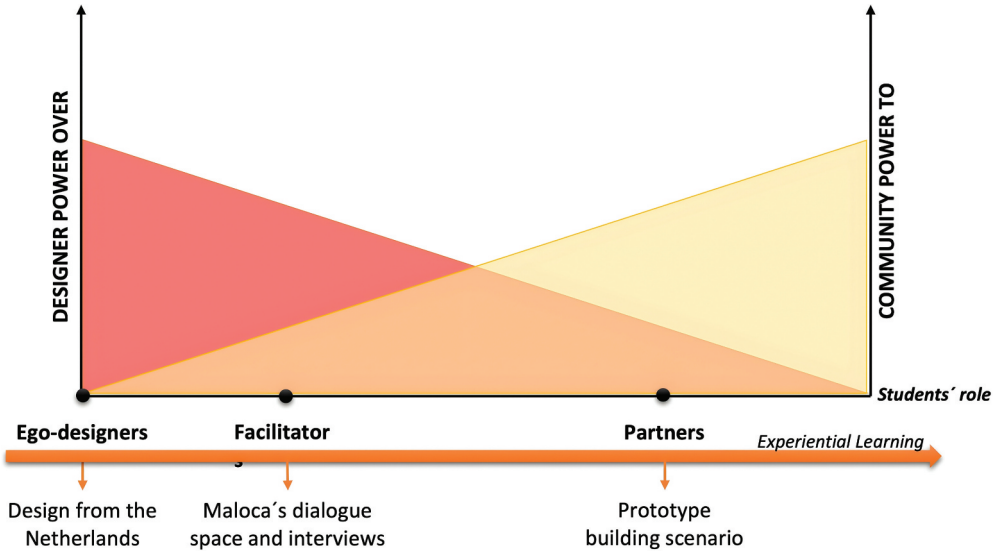

Figure 7. Students' design participatory role evolution based on the classification of Tomasini Giannini and Mulder (2022).

After showing and discussing the draft design with the Tikuna community, their role shifted to that of a partner in the process. For them, the prototype building was the scenario in which the community member assumed the leadership of the co-creation process, and the students left control to support them and learn from them about building construction and local materials. This transition to community empowerment was perceived as happening faster than the students expected, facilitating their engagement in the sustainable use of the drying-bark prototype.

The appreciation of traditional knowledge strengthened the journey through the students' decolonisation mindset. In the praxis reflection of the asymmetry in the knowledge dialogue, they realised that this knowledge was extensive, collective, and powerful. Thus, they valorised its transformative role in the progress of Indigenous communities. At the end of the fieldwork experience, traditional knowledge served as an eye-opener, prompting them to consider alternative knowledge systems beyond the hegemonic system.

Exploring insights on the prototype implementation impacts and sustainability

Participatory design projects in the Amazon region should address the real-world problems faced by Indigenous communities, providing sustainable and culturally sensitive solutions. Following this premise, the students assessed the social impact and sustainability of implementing the bark-drying prototype for vector-borne disease treatment.

The students considered two social impacts by analysing the positive and negative effects on the community, individuals, and cultural aspects. The first is cultural preservation, which is related to maintaining connections with cultural heritage and Indigenous identity through the management and processing of

Table 2. Identified aspects for prototype management sustainability.

Stages	Aspects involved
Design	User adoption and satisfaction
	Extended lifespan
	Collaborative decision-making
Gathering	Local material availability
	Cost-effectiveness
	Reduced environmental impact
Building	Local capacity building
	Knowledge transfer and ownership
	Knowledge dialogue

medicinal plants. Based on the community engagement approach, the knowledge transmission of the bark prototype building could raise awareness and prevent VBDs.

The second social impact considered is health and well-being. The bark prototype building and its use are also relevant to self-sufficiency in the VBD treatment strategies, as the students mentioned:'It ensures a consistent and accessible supply of traditional healthcare resources, promoting local autonomy and reliable access'.

This prototype offers an additional treatment option and enhances the preservation of traditional remedies for several febrile illnesses that affect the community. Regarding sustainability, the students examined the main aspects of drying prototype management (Table 2). Understanding user adoption and satisfaction is crucial for enhancing the acceptance of the prototype in the community and the practical relevance of healers' natural preparations. This adoption also increases the likelihood of an extended lifespan by properly using and maintaining the prototype, which reduces the need for constant replacements.

During the gathering stage, it is crucial to consider locally available materials and the involvement of local members in the selection of fundamental resources. For example, knowledge of the community's wood types is fundamental for the prototype's lifespan because Indigenous people are very selective about wood characteristics, considering durability, hardness, and cultural significance. These materials also ensure cost-effectiveness and reduced environmental impact by promoting ecological balance and preserving natural resources (Mashford-Pringle et al., 2023).

Prototype co-creation focused on capacity building and began with a group of interested community members. For the students, the presence of passer-by spectators joining to see what was happening with the prototype was enriching and motivating. They provided the construction team with advice and showed interest in the final result, as well as the presence of foreigners working in the community.

The combination of these previous aspects facilitated knowledge transfer and ownership. The students highlighted the permanent interaction with the community in various scenarios during the design and building process as a key factor in ensuring that local people understand the prototype's functionality and importance:'They know how to repair the machine if it breaks down and understand the logic behind the drying process'.

Despite the challenges in the knowledge dialogue due to language limitations and cultural barriers, the students expected that this co-creation process would foster a sense of ownership in the community, ensuring the responsible long-term use of

the drying prototype. Moreover, the students recognised that local people have a deep understanding of their environment and how to manage their resources sustainably.

A positive outcome of this co-creation process was observed in the socialisation space, where the students presented the final result to the community, and some healers expressed their ideas through the Tikuna language, emphasising the relevance and practical use of the prototype. Other community members participated in the experiments involving the drying and grinding of the bark. At the end of the experience, the students concluded that they could articulate their knowledge of drying and the community members' knowledge of building to overcome the particular challenges faced during the building stage.

Cross-cultural perspectives in global decolonial design experiences

The findings from the experience with the community of Puerto Esperanza contribute to a growing body of evidence demonstrating both universal principles and context-specific adaptations in decolonial design practice. Through a comparative analysis of documented initiatives across multiple continents, we identified critical patterns that inform pedagogical approaches to engineering education in Indigenous contexts.

The transformation of student roles from 'ego-designers' to collaborative 'partners' observed in our study aligns with the power redistribution patterns documented in the Tibaŋsim project in Northern Ghana, where external researchers similarly transitioned from technology providers to collaborative facilitators in co-creating digital information systems (Bon et al., 2022). Both cases demonstrate that meaningful power redistribution requires structured temporal phases, intentional process design, and sustained reflexive practice. However, the Amazonian context revealed additional complexities that are not prominently featured in other cases, particularly regarding traditional governance structures and cultural protocol navigation.

This finding suggests that decolonial design education must prepare students for varying levels of institutional complexity across Indigenous contexts. The eBario project in Malaysia provides a contrasting case in which technology-mediated collaboration between researchers and Indigenous communities resulted in sustained community ownership and locally defined development outcomes, demonstrating the effectiveness of participatory action research methodologies in diverse cultural contexts (Harris et al., 2018; Tomasini Giannini & Mulder, 2022).

While technology-mediated collaboration tools have proven effective in other contexts, the Amazonian context necessitated embodied, place-based methodologies, including Maloca dialogues and participatory construction activities. This methodological divergence underscores the cultural situatedness required for decolonial design approaches.

Final considerations

Interdisciplinary pedagogical praxis

This study contributes to the growing field of decolonial participatory design (PD) by emphasising the importance of interdisciplinary pedagogical praxis. By

integrating decolonial theories and experiential learning, we have illustrated how PD can be effectively applied in Indigenous contexts to address sustainability and health issues. Experiential learning enables students to engage deeply with decolonial theories and methods, particularly in addressing the challenges faced by Indigenous communities. However, engagement with Indigenous communities should not be undertaken lightly or without proper preparation. Before embarking on participatory action research (PAR) with Indigenous peoples, researchers and students must receive training that enhances cultural competence, self-reflexivity, historical awareness, and a clear understanding of the power imbalances and harmful practices, such as academic extractivism, that have historically marginalised Indigenous voices.

Reflection on participation and power dynamics

A critical aspect of our approach involved deciding who would participate and how. The degree of participation granted to community members significantly affected the project's process and outcomes. Leveraging higher degrees of involvement fostered greater control, accountability, and ownership among community members. Nevertheless, this inclusion must be accompanied by an awareness of the complex histories and ongoing struggles faced by Indigenous peoples, including exploitation, extraction, and violence.

Researchers and students must approach collaboration humbly, recognising that Indigenous community members are equal contributors of knowledge, not merely informants. Ensuring that communities benefit directly and meaningfully from the process helps to safeguard against exploitative practices. This reinforces a paradigm in which Indigenous voices lead, guide, and set the agenda for the work.

Collaboration over participation

Our findings suggest that 'collaboration' may be a more suitable term than 'participation' in the context of decolonial professional development. Collaboration implies a more egalitarian approach, in which projects are co-created with community members rather than being initiated or dominated by external designers or researchers. Such a shift helps dismantle hierarchical power structures, but only if accompanied by genuine efforts to respect local leadership, protect Indigenous knowledge, and refrain from profiting at the community expense. Non-Indigenous students, researchers, and practitioners must develop allyship grounded in respect, reciprocity, and a willingness to step back, allowing Indigenous communities to fully define and shape the work.

Decolonial participatory design process built on reflection and action

A decolonial participatory design process must be rooted in continuous reflection and action. For educators and researchers, this means adopting a value-based approach that emphasises social justice, kindness and compassion. Encouraging students to locate themselves within the research process, understand their positionality, and

appreciate Indigenous sovereignty can help prevent spiritual and knowledge bypassing, as well as other forms of exploitation. Such reflection also requires careful monitoring to determine whether the community truly benefits. If researchers and students profit through publications, grants, or career advancement while Indigenous partners do not, the collaborative process must be re-evaluated, and reparative actions must be taken.

Ensuring inclusivity and diversity in research dissemination

The responsibility for research dissemination extends beyond individual researchers. Professional and academic institutions must promote inclusivity and diversity by highlighting research influenced by non-Western philosophies and conducted by scholars from diverse backgrounds, including Indigenous researchers. Critically examining dissemination protocols ensures alignment with the principles of diversity, equity, and inclusion. This process involves actively resisting academic extractivism, amplifying the voices of marginalised individuals, and ensuring that Indigenous knowledge holders are recognised and retain control over how their knowledge is shared and applied.

Community-centred design solutions

In design justice pedagogy, it is essential to honour and uplift traditional, Indigenous, and local knowledge and practices before introducing new solutions. Educators should encourage engineering students to form teams to explore and amplify existing community initiatives rather than defaulting to technologically driven projects that may not serve local needs. By doing so, we affirm Indigenous community members as leaders, rather than subjects of research. Non-Indigenous allies must learn to support such leadership and guard against subtle forms of appropriation, ensuring that communities retain ownership of their intellectual and cultural contributions.

We further reflect that decolonising participatory design fundamentally requires the valuing and prioritising of local knowledge systems and storytelling traditions within the design process. True decolonial practice emerges when communities co-own the process: their voices shape the project from conception to implementation, and they retain shared authority over the process and any data or knowledge generated. We see this co-creative, power-sharing model as an ethical imperative one that not only respects Indigenous sovereignty and agency, but also leads to more culturally grounded and sustainable outcomes.

Recommendations for future research

Future research should continue to explore the intersection of decolonial theory and participatory design, focusing on the long-term impacts of decolonial participatory design processes on community well-being and sustainability. Crucially, future work must incorporate rigorous training programmes that prepare researchers, especially non-Indigenous researchers, for respectful and equitable engagement with Indigenous

communities. Developing and refining methodologies that facilitate genuine collaboration, knowledge co-creation, and mutual benefit will help ensure that participatory action research with Indigenous peoples is conducted ethically, responsibly, and in a manner that truly supports community-led innovation and sovereignty.

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Ethical approval

The use of the information gathered from the workshop 'Decolonial participatory design perspectives with Indigenous communities' was approved by the Human Research Ethics Committee (HREC) of TU Delft, application number 4585.

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