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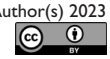

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Decolonizing western science education and knowledge in early childhood: Rethinking natural hazards and disasters framework through indigenous 'ecology of knowledges' in Kenya

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Abstract

This article presents the epistemological complexity inherent in the roll out of an international project on Disaster and Risk Reduction, and consequently about science education in the Indigenous context of Turkana County in Kenya. After an introduction that explains the current state of Disaster and Risk Reduction, the paper focuses on the 'Paper Volcanoes Laboratory' program and toolkit for children and teachers, which aims to spread awareness about natural hazards among children. The paper argues that the geographical, social and educational context where the project is carried out is critical to consider, and decolonial studies provide a conceptual and theoretical framework for this project. This allows to recognize reproduction of infantilization of Indigenous people and children through Western knowledge and science if implemented without consideration for local contexts, and demonstrates how Western educational projects have been a tool of discrimination and colonization. However, at the same time, it opens up the possibility for a dialogue and an encounter between the different

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epistemologies present in a project that was conceptualized within the Western context, but is to be carried out in Turkana County in Kenya.

Keywords
decolonizing western science education, disaster and risk reduction, early childhood, indigenous ecology of knowledges

Introduction

Natural disasters affect about 175 million children per year. With the increase in natural disasters attributed to climate change, children are also victims of climate change events that the previous generations did not experience (Codreanu et al., 2014). Natural disasters impact children more than adults (Kousky, 2016; Peden et al., 2008) in their physical health (Alexander and Magni, 2013; Cao and Kamel, 2011; Glass et al., 1977; Ramirez et al., 2005) and mental health (Jia et al., 2010; La Greca et al., 1996; Norris et al., 2002; Schonfeld, 2004; Taylor and Weems, 2008; Telford et al., 2006; Udwin, 1993). Natural disasters also create severe disruptions to children's education (Achoka and Maiyo, 2008; Peek, 2008). Other literature also highlights how children have particular skills that help them deal with natural disasters (Bartlett, 2008; Mitchell et al., 2008; National Commission on Children and Disasters, 2010).

Children should be recognized as having an active role in dealing with disasters. Their agency needs to be considered when conceptualizing disaster management strategies. It is critical for children to develop awareness about natural disasters to prevent or at least reduce the negative impact of these events. Education plays an important role in preparing children and communities for natural disasters. Traditionally, education about natural disasters is carried out by civil protection departments, government institutions and within specific projects (Crescimbene et al., 2018; D'Addezio et al., 2014; La Longa et al., 2012; Orlando et al., 2016; Piangiamore et al., 2016). Schools also have an important role through Disaster Risk and Reduction (DRR) programmes. By incorporating DRR into classrooms, children are supported in their preparedness for natural disasters (Amri et al., 2018; Bernharðsdóttir et al., 2012, Bernharðsdóttir et al., 2015).

However, there are two important shortcomings to many of the DRR programmes. First, the effectiveness of these programmes is limited by the extent to which they engage wider communities. Muzenda-Mudavanhu et al.'s (2016) research in Zimbabwe found that DRR programmes increased children's awareness and knowledge of natural disasters; however, this did not translate into natural disaster preparedness because children's ability to respond was tied up with the preparedness of their families and communities. Children's vulnerability to natural disasters is closely connected with the abilities of their parents (McNeill and Ronan, 2017). So, for DRR programmes to be effective, it is not enough to give children knowledge. The programmes need to help share knowledge and develop preparedness across wider communities while also giving children access to resources and support. To improve DRR programmes, it is essential to engage parents as well as schools and teachers (Vitek and Berta, 1982). DRR programmes need to build community resilience.

The second shortcoming of many DRR school programmes is that they exclude young children. Amici and Castello (2018) note that a wide range of natural disaster educational resources are available to school-aged children, while the resources for preschool children are almost non-existent. Engaging preschool children in DRR programmes is important.

The Paper Volcanoes Laboratory (PVL) program responds to both these shortcomings. As is discussed in the next section, PVL is a DRR programme designed to engage preschool children as well as their families and communities (Amici and Castello, 2018; Amici et al., 2022). The PVL was created following the enquiring-based learning and the 'object play' approach, which uses two activities – creating an origami volcano and volcanoes-themed colouring – to engage children and help them to familiarize themselves with volcanic hazards (Amici and Castello, 2018).

The PVL project also makes rich and strong connections with local communities by engaging with Indigenous ontologies and epistemologies. In many Indigenous cultures, there is a strong connection between storytelling and science (Vitaliano, 2007). Stories have been used to describe earthquakes, volcanoes, flooding and the shapes of the local environment. For example, inspired by local volcanic activity, Māori tell the story of Tongariro who battles three strong mountains – Taranaki, Tauhara and Putauaki – to protect his wife, Pihanga. Through the Māori story, children learn about volcanoes and how powerful their eruptions can be. Another example from a different part of the globe is the Efesto Greek (Volcan Roman) story of the fire god forged within Mount Etna (Quarenghi, 2001). This story communicates volcanic risk (Di Nezza et al., 2018). The PVL project challenges its content and methodology by drawing on Turkana culture and forms of knowledge, including storytelling. This approach connects and enables local knowledges, tales and philosophies (Tesar et al., 2016).

The Paper Volcanoes Laboratory

The PVL is a program conceptualized within the National Institute of Geophysics and Volcanology (INGV) Educational group in Italy that aims to familiarize children on natural disasters and help them to develop agency to manage the possible consequences of a volcanic eruption (Amici and Castello, 2018). The PVL program is based on an inquiry-based learning approach that allows children to be engaged and direct their own learning process. Since 2016, the laboratory has involved more than 390 children at national and international scale.

The activities that make up the PVL program have been tested in the field, perfected and subsequently structured in a science educational resource, the Paper Volcanoes Laboratory Toolkit (Amici and Tesar, 2020). The toolkit includes a 'Guide for educators' that explains in a child-friendly way what a volcano is and provides scientific knowledge about the topic, and two 'Guides for teachers' that suggest two activities that can be used with children. Pilot projects were successfully run in Western volcanically active countries including Italy, USA, New Zealand and Australia. Then, the toolkit was tested during six INGV open days at pre-schools – three in Italy and three in New Zealand (Amici and Castello, 2018; Bone and Amici, 2019; Castello et al., 2019).

Following the feedback from the INGV colleagues, children and teachers, a project named *Paper Volcanoes Lab: A way to engage early childhood and primary school children on Earth Science*, was submitted to the International Union of Geodesy and Geophysics (IUGG) Grants Program under the priority area Geoscience education and outreach in developing countries. The project aims:

- to support the preschoolers and primary school age children who live in countries with volcanic activity to familiarize with the wonders and the associated risks of volcanoes by using an object play approach as developed in the Paper Volcanoes toolkit
- to enhance the educational experiences of (pre) primary school aged children in East Africa by connecting them with an understanding of volcanoes and to their cultural significance
- to engage young children – researchers, teachers from developing countries and senior researchers and academics from international institutions to foster collaborative work.

- to increase educators' scientific content knowledge and pedagogical skills
- to test and evaluate the Paper Volcanoes tool kit in diverse contexts where the relationship between communities and volcanoes has cultural significance
- to prepare earth science educational materials based on the school curriculum in Kenya and see how it can be scaled up towards other countries in Africa and other developing nations.

The communication of geoscience natural hazards to K6 and K12 children can play a role in enhancing people's knowledge of volcanoes and their preparedness to respond to possible volcanic activity or other geophysical phenomena such earthquakes. In this framework, the communication of geohazards is critical. The project questions are:

- Can the PVL lab used in the frame of African education system?
- Can the PVL lab be used in a primary school context as well? How do we need to adapt the activities?
- Can the PVL lab play a role by linking researchers and teachers to raise awareness of the impact of geoscience knowledge in developing countries?
- Can the PVL lab be used to increase the learning area of geoscience?

This paper conceptualizes how the PVL toolkit can be implemented in the Indigenous cultural and educational setting in the Turkana community in Kenya and how cross-cultural encounters need to be conceptualized to avoid the reproduction of colonization and discriminatory practices.

Volcanism in Kenya

Volcanism is not part of the curriculum in Kenyan early childhood education centres or schools, and knowledge about volcanism is not common in the wider Turkana communities. Turkana people refer to an active volcano as a Smoky Mountain, the Mountain of Fire, or a Spiritual Mountain. Turkana people utilize storytelling understand how cone-shaped hills and the rocky mountainous nature of their land were formed.

These hills and mountains are part of the Rift Valley. The land of the Turkana people is part of the East African Rift System (EARS) – an area of active volcanic activity which has been the site of significant eruptions in the past. For example, in Eritrea, the Dubbi eruption of 1861 was one of the largest eruptions ever recorded in Africa; lava travelled up to 22 km, and the eruption's impact reached as far as 300 km, destroying villages and killing many people and animals. The EARS region is also the site of large human settlements and major urban towns. Many of Kenya's volcanoes are sites of human activity and mining, such as Alkaria, which is home to a large-scale geothermal energy mining project operated by the Kenya energy company. The presence of geothermal activity means the possibility of a volcanic eruption in the future.

A major challenge for the EARS region is the insufficient systematic data on eruptions in Africa. In Kenya, there are 31 documented volcanos with limited recorded data on their eruptions that could help provide early warnings for future eruptions. One of these 31 volcanoes is Suswa – situated 50 km from Kenya's capital city, Nairobi, in the southern part of the Kenyan Rift Valley. Suswa contains a 12×8 km caldera (Biggs et al., 2009; Pyle, 1999); due to its proximity to Nairobi, this volcano would pose a significant natural hazard to human life if it erupted. Despite signs that volcanoes such as Suswa may erupt in the future, Kenya has no monitoring infrastructure to study the volcanoes along the rift axis (Mulwa et al., 2014). Even though Kenya hasn't experienced volcanic natural disasters in recorded human history, volcanic activity does pose a risk. In the Kenyan

Rift, the valley floor is covered by effusive lava flows and ashfall deposits from historical eruptions. Today, satellite observations have identified ground deformation at several volcanic centres, especially at Logonot, Paka, Menengai and Suswa. These deformations are evidence of extensive magmatism throughout the Rift Valley (Biggs et al., 2009; Pyle, 1999). Kenya is seismically active since the eastern part of EARS traverses through the country from north to south, bisecting the country into eastern and western regions. Historical records show that large magnitude earthquakes occurred in 1928 in Subukia and in 1913 in the Turkana region (Ambraseys, 2007). The seismic hazard of this part of East Africa, deduced from data of the last 95 years, is significant (Biggs et al., 2009; Pyle, 1999), and Turkana county lies on the Eastern side of EARS.

The region has active volcanoes which pose a direct threat to the surrounding communities, including children and traffic routes. Volcanic eruptions can result in hazards including lava flows, hazardous gases and ash falls (Lenhardt and Oppenheimer, 2014). These hazards could result in injuries, fatalities, damage to infrastructure, contaminated water supplies and the long-term displacement of communities. The importance of anticipating volcanic eruptions became clear with the 2011 eruption of Nabro in Eritrea. The area was intensively settled due to the rainfall and highlands making it ideal for agriculture (Lenhardt and Oppenheimer, 2014). When Nabro erupted, the local communities were surprised; they had no idea that Nabro was a threat. Communities in Kenya, including young children, benefit from the knowledge of how to be vigilant and prepared for any future volcanic activity. In the Turkana EARS region, there are a number of volcanoes – such as Suswa, Longonot, Subukia and Alkaria – that pose a large risk to settlements and their socio-economic activities. While Turkana people live unimpacted by potential volcanic activity, there is a need to consider future scenarios. This issue is particularly pressing due to Kenya's lack of proper monitoring systems.

The Turkana community and education

Turkana (Ng'turkana) County is part of the former Rift Valley Province of Kenya. It is Kenya's largest county with an area of 77,000 square kilometers and a population of 926,976 (according to the 2019 census). It borders Uganda to the west and South Sudan and Ethiopia to the north and northeast. Turkana is a semi-arid region. Its land consists of flat lands, isolated cone-shaped hills and long ranges of the Rocky Mountains. The lowlands form the basin in which Lake Turkana lies, with oasis springs that can be cold or hot depending on whether they are from the mountain top or the well-known Suguta Valley hot springs.

Turkana is a pastoralist nomadic ethnic community that speaks Turkana, an Eastern Nilotic language. The Turkana maintain their own cultural traditions despite the long period of colonization by the British Empire. The Turkana are also a culturally and economically marginalized community (Ng'asike, 2010). Compared to other Kenyan nations, the Turkana have lower standards of living, education and healthcare. Ninety-six per cent of Turkana people suffer from poverty (Gisesa, 2010) and rely on Government and humanitarian organizations for food.

The education system in Turkana is a legacy of the British Empire that colonized Kenya in 1888 and was carried on by missionaries, churches and NGOs whose main goal was to 'spread Christianity' (Alwy and Schech, 2004, p. 270) and 'perpetuate Western culture in education across rural communities, irrespective of the cultural context of the people' (Ng'asike and Swaderner, 2019, p. 113). In 1924, the British government sponsored separate educational systems for Europeans, Asians and Africans. However, funding was not equally distributed across these systems, with European students receiving five times the amount of funds that went to African students (Alwy and Schech, 2004).

When Kenya gained independence in 1963, it inherited its education system from colonialism. Even though Kenya now had control over educational policy, the political elites that were now in charge of reshaping Kenya's education system were products of colonialism. The rich history of Indigenous education and knowledge had been decimated. Consequently, Indigenous approaches could not simply re-emerge and flourish post-independence. Instead, post-independence education was deeply enmeshed in Kenya's immediate colonial past.

Nevertheless, independence did see some positive developments. The Ominde Report of 1964 promoted equal opportunity, abolished racial segregation and aimed to respect and develop the cultural heritage of Kenya. Since independence, educational reports and scholars have recognized the importance of integrating Indigenous knowledge and the perspectives of local communities (Inyega et al., 2021; Owuor, 2007).

But despite this recognition, change has been slow and superficial. Education in Kenya continues to be dominated by its colonial past. At independence, Kenya did not have the capacity of Indigenous educators to develop a curriculum that sufficiently represented Indigenous peoples. There was still a reliance on foreign educators and foreign educational systems. Kenya was also economically reliant on Western countries. A main priority of education was Kenya's economic development. Since development was deeply wedded to Western systems, education continued to be dominated by Western knowledge (Owuor, 2007). Faced with such difficulties, education continued resorting to the status quo established by colonialism.

Kenya has been unable to relinquish its colonial and discriminatory past. The decisions of the political elite are still deeply tied to Western ideals. Consequently, education in Kenya continues to operate in ways that supplant local cultural ways of knowing with Western thinking and lifestyles (Ng'asike and Swaderner, 2015). The results of these discriminatory practices are visible in the school system in Turkana County. Ng'asike and Swaderner (2019) point out that schools are built without consideration for the environment and needs of Turkana children and families. The Turkana community has not been part of the construction of the curriculum. Consequently, the curriculum has very little relation to their own cultural context and instead perpetuates Western ideology. Families and communities are outsiders to their children's education. Teaching in schools rejects Turkana's cultural values, further contributing to the discrimination and marginalization of the community. In school, children are taught that their culture is barbaric, archaic and primitive (Dyer, 2006; Ntarangwi, 2003); schools in effect teach children to 'hate themselves' (Ntarangwi, 2003). Education is presented as progressing from a primitive, nomadic culture, to a modern industrial economy (Ng'asike, 2011).

Science education follows this same discriminatory pattern. Science education does not consider Turkana knowledge, viewing it as irrelevant and unscientific (Ng'asike, 2010). This tendency is mirrored in the textbooks that are used to teach science in a way that represents Western culture and not the Turkana environment and cultural knowledge (Ng'asike, 2011). So, when Turkana children engage in science education, their worldview, knowledge and way of life are absent (Ng'asike, 2010). Turkana children have a strong relationship with nature; however, the Western science education that they are subjected to fails to engage Turkana children's knowledges about the place and space where they learn, play and grow up. They swim, climb trees, pick fruit, hunt birds and herd livestock. These rich experiences are not used by teachers in science education. Instead, teachers give precedence to textbooks, chalk and blackboards and rote memorization (Ng'asike, 2010).

There are alternative possibilities for how Turkana children can learn science. According to Ng'asike (2010, 2011), Turkana children need a science education that recognizes and is consistent with their environment and their culture. Children can learn theories of science through their own environment and traditional way of life. Integrating scientific knowledge with local knowledge

will enhance both their scientific understanding as well as their confidence, self-esteem and motivation. There is a need for an ethics of care for Kenyan childhoods (Arndt et al., 2016), as well as creating communities of 'care' apart from 'education' (Ailwood et al., 2022). The PVL project attempts to pursue this possibility.

Infantilization and epistemicide

Any social or educational project for an Indigenous community must reflect on its ontology and epistemology to avoid the reproduction of discriminatory and colonial practices (Adriany and Tesar, 2023; Mutua and Swadener, 2011). Education and science education have been a tool to perpetrate forms of discrimination and colonization. To avoid reproducing such practices, the PVL project takes children and Turkana community members' points of view into the centre of the inquiry.

Through impacts of colonization, the Turkana community has been subject to infantilization. Indigenous children and people have been treated as infants (from the Latin *in-* and *– fāri*) that means who does not speak, who is not able or who cannot speak for themselves and needs the help of someone who can make decisions, act and think in their place. Infantilization is the mechanism that reduces the Other to a dependent and incompetent and establishes relations based on power. As Alcubierre (2016) puts it, infantilization 'refers to the historical process by which a growing portion of society would be seen as naturally weak, heteronomous and needing protection' (p. 329). A group is made dependent on the supposed superiority of a dominant group or ideology, and the dominant group infantilizes the subordinate group by talking down to them. Infantilization serves to exclude children from the adult world through practices that curb children's agency and power (Tesar et al., 2021a). This process is not limited to children; stretching the philosophical and legal limit of the infantile category, infantilization turns into children's age groups those that were not necessarily considered part of childhood before the seventeenth century. In this way, the institutions and the State have been able to control, domesticate and silence a wider part of the population (Alcubierre, 2016).

Education and literacy played a central role in forming the unquestioned – and widely accepted – differences between children and adults. These aspects also play an important role in infantilization and in the establishment of power hierarchies. These hierarchies subjugate not only Indigenous children but also adults (Ashcroft, 2001). Ashcroft (2001) suggests that the category of childhood emerged

> in Western society after the invention of the printing press, when the subsequent spread of literacy had created a clear division between child and adult which could only be bridged by a more systematic form of education. . . In the same way, for imperialism, the idea of literacy and education, even where these were imposed on already literate societies, represented a defining separation between the civilized and the barbarous nations. (p. 39)

Infantilization happens through imposing the idea of knowledge and the way to know. This imposition on Indigenous people has been used to justify colonization and cement the idea and performance of Western superiority. By not acknowledging other ways of knowing and communicating, colonizing agencies assumed that Indigenous people were not only 'savages', 'uncivilized' and 'primitive' people (Ashcroft, 2001; Liebel, 2017), but also illiterate and uneducated, 'like children'. As such, any knowledge and 'cultural difference from, first the European cannon, now the homogeneous globalized world, was not respected but tread as major disability and needed to be either corrected or eradicated' (Espinosa-Dulanto, 2004, p. 47).

Using epistemologies of decolonial studies in forming the theoretical framework of PVL project means not reproducing forms of infantilization that undermines Indigenous peoples' knowledge. Although coloniality is associated with political and economic events, Quijano (2007) underlines that the colonial domination of knowledge continues even after political independence (Ng'asike, 2019). The colonization of knowledge is the result of multiple systems of repression. These systems repress Indigenous beliefs and ideas. Furthermore, they repress Indigenous ways of knowing and Indigenous ways of producing knowledge. Colonizing agencies repress the images and modes of meaning used by Indigenous peoples (Quijano, 2007). The repressive systems glorify colonizing agencies images, beliefs and expression patterns. In this way, these systems elevate colonizing modes of knowledge production and are imposed on the dominated. These systems then become tools to access power, meaning that colonized cultures become dependent on Western modes of knowledge production (Quijano, 2007). de Sousa Santos (2004) describes this systematic suppression of Indigenous knowledge as a form of epistemicide that drove to the 'monoculture of scientific knowledge and rigour' and to the nonexistence of those other traditions (p. 165). The monoculture of knowledge means that modern science and western culture are considered the authority on truth and the custodians of the knowledge canon (Malone et al., 2020).

Decolonising science education

To surmount the monoculture of knowledge, de Sousa Santos (2014) proposes to substitute it for an 'ecology of knowledges' that recognizes and assesses the existence of a plurality of knowledge beyond scientific knowledge. The ecology of knowledges contains 'non-relativistic dialogues among knowledge engaged in ever broader epistemological disputes aimed both at maximizing their respective contributions to build a more democratic and just society and at decolonizing knowledge and power' (de Sousa Santos et al., 2007, p. xx). Its entry point is focused on the acknowledgement that 'there is no ignorance or knowledge in general. All ignorance is ignorant of a certain knowledge, and all knowledge is the overcoming of a particular ignorance' (de Sousa Santos, 2004, p. 168). This idea opens the possibility to create new relationships between scientific and alternative knowledge (de Sousa Santos et al., 2007, p. xlix). De Sousa Santos differentiates between 'equality of opportunities' and 'equal validity'; that is, ecology of knowledges guarantees 'a pragmatic discussion of alternative criteria of validity' without disqualifying other non-scientific, alternative knowledge a priori (de Sousa Santos et al., 2007, p. xlix).

The change from a monoculture of scientific knowledge to an ecology of knowledges means replacing knowledge-as-regulation with knowledge-as-emancipation. Both these conceptions of knowledge follow the trajectory from ignorance to knowledge. But knowledge-as-regulation understands this trajectory as a movement from disorder to order, whereas knowledge-as-emancipation understands it as a movement that overcomes colonialism to attain solidarity (de Sousa Santos et al., 2007, p. li). Understanding knowledge-as-emancipation reconfigures the roles of the agents of knowing – namely, Indigenous people or children. Knowledge-as-emancipation implies changing the power and hierarchy in relationships. The asymmetric dichotomies that characterized colonial and generational relationships – 'donor/recipient, developed/undeveloped, knowledge/ignorance, teaching/learning, thinking/acting, recommending/following, designing/implementing' (de Sousa Santos et al., 2007, p. xxxviii) – are disrupted and fall down.

Knowledge-as-emancipation points to possibilities for science education to be decolonized. We can rethink the position of the agents by creating space for their knowledge to be at the centre of educational practices and research. An educational project needs to be shaped by the modes of existence and knowledge production that are valued by a community (Bobbette et al., 2021;

Menon et al., 2021), but also taking into considerations relationships between education, philosophy and methodology (Tesar, 2021).

Western curriculum and pedagogy operate to either validate or marginalize systems of knowledge production (Shahjahan et al., 2021; Yang et al., 2022). Recently, academics, activists, student movements and Indigenous movements have called for decolonizing curriculum and pedagogy. An increasing number of studies have been focused on the decolonization of scientific knowledge and its teaching (Bobbette et al., 2021). They specifically respond to the call to decolonize science education, including scholars actively seeking to protect Indigenous knowledge that has been threatened by Western colonization, post-colonization, settler colonialism and neoliberal globalization (Belczewski, 2009; Quigley, 2009; Yelland et al., 2021).

The decolonization of science education increases Indigenous students' engagement in education (Belczewski, 2009), allowing them to make connections between their Indigenous knowledge and science education. It allows Indigenous children to grow up, thrive and succeed as Indigenous children and students in their colonized lands. Without these connections, there is a risk that Indigenous students may question their identity as at odds with the 'ideal student' that engages with science (Aikenhead and Elliott, 2010). On the other hand, when science education includes Indigenous knowledge, it creates possibilities for students to engage in science while affirming their Indigenous identity.

Including Indigenous knowledge creates a radical opening to new philosophical thinking about the Indigenous future of childhood (Tesar et al., 2021b). Decolonization has specific implications for how we understand early childhood. Viewing childhood through a decolonial lens reveals how our ideas on children are shaped by colonial Western knowledge, narrative and power (Cannella and Viruru, 2004; de Castro, 2019; Diaz-Diaz, 2021; Liebel, 2020; Nxumalo, 2019; Pacini-Ketchabaw and Taylor, 2015). Research has also specifically explored early childhood science education through a decolonial lens (e.g. Cabe Trundle and Saçkes, 2015; Ravanis, 2017; Roth et al., 2013). However, research on practical programs that attempt to decolonise science education in early childhood is limited. In this nascent research area, scholars have concentrated their attention on integrating Indigenous knowledge in the early childhood curriculum and avoiding the risk of 'repeating inherited colonial narratives and practices' in early childhood education (Diaz-Diaz, 2021, p. 3).

These attempts at decolonization are not a predominate feature of early childhood science education. Most of the research in this area is pre-occupied with studying the best strategies and pedagogical practices to teach science concepts and develop inquiry skills. However, these concepts and skills are uncritically employed and do not take seriously Indigenous knowledge and approaches. If the cultural background is made a part of science education, it is to facilitate children's learning of new knowledge (Saçkes, 2015, p. 35). The knowledge that children bring into the classroom is reduced to prior knowledge. This prior knowledge is valued only in terms of its instrumental ability to develop better scientific understanding. Consequently, Indigenous knowledge becomes knowledge to be built on or replaced, and this knowledge becomes irrelevant from a Western scientific point of view.

Children's experience is considered immature, deficient and it needs to be changed through efficient pedagogical methodologies. Traditionally, Western scientific research does not consider children's different points of view as a possible divergent way to know the natural world or natural hazards (Tesar, 2016). Children are seen as incapable of bringing a different understanding of our reality and are dependent on the knowledge of adults. Moreover, science education in early childhood has been regarded mainly from a Western science perspective. There are only a few studies regarding how to integrate Indigenous knowledge in early childhood curricula in Kenya (Ng'asike, 2010, 2011; Ng'asike and Swaderner, 2019).

Decolonizing the PVL toolkit

In the Turkana community of Kenya, Ng'asike (2014, 2019) demonstrates how the formal curriculum is a continuation of British colonial education. The curriculum does not respond to the values and needs of pastoralist and nomadic communities. Although the Kenya Institute of Curriculum Development has called for teachers to 'contextualize learning to reflect the cultural needs and local experiences of children' (Ministry of Education & UNICEF, 2008, as cited in Ng'asike, 2014), in reality, classroom instruction passes over the cultural needs of communities and cements Western views and values of knowledge. One example of how Turkana knowledge is passed over is in how the calendar is taught. The Turkana calendar has twelve months and seasons. However, this knowledge is not acknowledged in the science curriculum or in any other related curriculum content. Instead, priority is given to the Western Gregorian Calendar. Another example is the absence of livestock herding in the curriculum. Livestock herding is a central part of Turkana knowledge and culture that the curriculum fails to engage with. In these ways, curriculum and classroom instruction ignores important cultural knowledge, causing children to become alienated from their families and culture.

Kenyan education policies are insufficient for ensuring that Turkana children receive a high-quality education that values their culture. While there is a nomadic education policy, it has not been practically implemented in a way that gives Turkana people any meaningful agency. Instead, the policy is a bureaucratic fixture that is only effective for pleasing donors. The Competency-Based Curriculum is a good policy, but since the implementers are not pastoralists, the policy has had only minimal success for Turkana people. Due to the insufficiency of these policies, education remains under the control of people outside the Turkana community who remain steeped in Western education.

The use of Indigenous science knowledge has not been recognized in the Kenyan education system; however, this is critical in supporting children to learn science in their country, and in developing their own natural hazards and disasters framework, based upon their own Indigenous knowledge. Supporting children's rights to education includes implementing policies that ensure Turkana children are provided with an education that is rooted in their culture and affirms and builds on their communities' knowledge. The erosion of Indigenous culture in Turkana children starts in early childhood education through the implementation of Western, Euro-centric knowledge (Prochner and Kabiru, 2008). Current education policies are failing to account for Indigenous knowledge and education for Turkana children.

Education in Turkana needs to improve itsresponsiveness to the Indigenous culture and knowledge of the community. Ng'asike (2019) has identified two important ways that education in Turkana can be made more responsive. First, he argues for integrating Indigenous knowledge and language. Second, the educational materials need to reflect the Indigenous culture and the local environment. These changes need to be implemented by educational leaders at all levels – all the way from education officers at the national level down to the principals of schools who are working in the Turkana community. Educational leaders need to see themselves, not as custodians of a national top-down curriculum, but instead as supporters of local knowledge and practices. By taking these steps, education can authentically engage children and communities.

The PVL project and toolkit for Turkana children has been developed in line with these considerations. Furthermore, the PVL project for Turkana children is informed by the decolonization approach of Shahjahan et al. (2021), who describe how monocultural perspectives place constraints on social practices. Decolonization of science breaks the monocultural dominance by disrupting the constraints of Western, Eurocentric and neoliberal thoughts, creating space for Indigenous perspectives, and an alternative view of what counts as knowledge and data (Koro-Ljungberg et al., 2019).

This approach to decolonization has been utilized in the development of the PVL project and toolkit in Turkana in several ways. First, by organizing a cross-cultural workshop that invites a conversation about volcanoes between scholars, Turkana teachers and community elders. These conversations enable all participants to rethink and reformulate the PVL project and toolkit in ways outside of a monocultural perspective. Second, by conducting a workshop with Turkana early childhood teachers to collectively determine how to respectfully use Turkana knowledge to create and empower the content of the PVL toolkit. Finally, by running a workshop that aims to seriously and deeply recognize Indigenous children as active learners who produce and reproduce their own culture and learnings. This decolonial and de-infantilizing approach allows the Turkana community to share their conceptions of childhood, challenge the Western view of science and lead the knowledge production for their community. The workshops aim to re-design the toolkit to reflect an ecology of knowledges between Western and Turkana cultures, and to ensure that culturally relevant practices and knowledges are the foundation of learning for Turkana people and children.

While the PVL project still maintains its original aim to familiarize and prepare children for natural hazards and disasters, it is also a tool of decolonization by recognizing Turkana epistemologies as valuable, meaningful and important in the production of new knowledge (de Sousa Santos, 2010). By taking this approach, children can learn about volcanoes via their own knowledge, without changing or re-writing their histories and identity. By following this decolonization approach, the PVL project strives to collaborate with the Turkana community to develop ways of learning, teaching and producing knowledge that is connected in meaningful ways to Turkana culture and knowledge. Such collaboration requires a deep partnership between all actors. The project will not exist without the knowledge, and active and authentic participation of Turkana community, teachers and children. As Han (2016) recognises:

> [If] the self requires the collaboration of the other, then a dependence of the self on the other arises. The self can no longer formulate or impose its demands without taking the other into consideration, since the other has the possibility of reacting to the coercion of the self, for example by renouncing its collaboration, which would put the self in a difficult situation. This is how the dependence of the self on the other can perceive and apply it, the latter, as a source of power. (p. 16)

In implementing this meaning of collaboration, the power hierarchies of colonialism are challenged and disturbed. Collaboration is not merely a welfarism/pietism that hides an unbalanced distribution of power between different stakeholders and cultures. Collaboration involves a relationship where these groups recognise their interdependence. For the PVL project, this means that the content and materials of the toolkit are developed collaboratively in workshops with the Turkana community, instead of being prefabricated and imposed on the Turkana community by Western researchers.

The PVL project and toolkit are implemented in ways that are responsive and adaptive to the particular context. For example, when the PVL project is introduced at workshops, it begins with showing a volcanic rock and asking teachers, ‘What is this?’. When the workshop was held in the Turkana community the volcanic rock used was a sample collected from a local volcanic mountain. Some of the teachers found the rock familiar, and some could identify the place where the rock was collected. The name of the volcanic area in Turkana language was written on a board beside the English names. A few of the teachers recalled a story related to the mountain of fire. This was the starting point of a storytelling approach which is informing the development of the project. In this way, the PVL project is not a fixed curriculum that is generically applied. Rather, it is a project that adapts and develops in collaboration with local communities.

Authentic collaboration does not only reformulate the content of the PVL project and toolkit, but also reconceptualises the project methodologies. This collaboration introduces activities not necessarily associated with science education, such as storytelling, collaborative ethnography, narrative writing inquiry and many others. These methodologies are a foundational part of the Turkana Indigenous scientific thinking.

Indigenous people, students and children lead the Turkana PVL project in order to re-think and decolonise the natural hazards and disasters framework through the Indigenous 'ecology of knowledges'. The decolonization of Western science education is a critical opportunity to rethink the relationship between Western and non-Western societies, peoples and environments, as well as Indigenous students and the educational systems. The process of decolonization cannot remain just a theoretical approach. It needs to become the social practice of the projects in non-Western countries. Projects like PVL must be conducted not only with, but also *by* Indigenous people, students and children.

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