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Augmenting Ancestral Narratives: The Role of AR/VR in Preserving and Transmitting Indigenous Knowledge in Australian Education

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Abstract

This research investigates the pedagogical efficacy and ethical complexities of integrating Augmented Reality (AR) and Virtual Reality (VR) into the Australian educational landscape, specifically regarding the transmission of Indigenous 'ways of knowing, being, and doing.' While traditional Western curricula often reduce the concept of 'Country' to abstract information, this study explores how Extended Reality (XR) can facilitate an ontological shift toward relational and spatial learning. Employing a convergent parallel mixed-methods design, the study evaluates student knowledge retention through a quasi-experimental intervention (n=120). It formulates ethical protocols via Participatory Action Research (PAR) involving Yarning Circles with Indigenous Elders. Quantitative results demonstrate a significant disparity in pedagogical outcomes, with VR-immersed students achieving 42% higher accuracy in identifying complex ecological interdependencies than traditional cohorts. This success is attributed to 'Embodied Cognition' and 'Spatial Pedagogy,' which provide a cognitive scaffold for relational retention. Qualitatively, the findings highlight 'Digital Colonialism' as a primary barrier, necessitating a move toward Indigenous Data Sovereignty (IDS). To address this, the study developed the 'Geofenced Sovereignty' protocol, ensuring that sacred digital assets remain tethered to their geographical origin. By centering the authoritative voice of Elders through a 'Digital Campfire' model, the research concludes that XR serves as a powerful conduit for Makarrata (Reconciliation) when governed by a community-led 'Sovereign Infrastructure.' Furthermore, the study establishes that these immersive simulations act as vital archives for intergenerational knowledge transfer, effectively bridging the digital divide while fostering profound cross-cultural empathy through multisensory narrative engagement. This paper provides a rigorous blueprint for utilizing the world's newest tools to ensure the survival of the world's oldest living culture in the 21st century.

Keywords: Digital Colonialism, Indigenous Data Sovereignty, Indigenous Knowledge, Mixed-Methods Research, Makarrata, Spatial Pedagogy, Virtual Reality.

1. INTRODUCTION

The epistemological landscape of Australian education is currently undergoing a profound re-evaluation as it seeks to reconcile Western pedagogical structures with the sophisticated, living wisdom of the world's oldest continuing cultures. Indigenous Knowledge (IK) is not a static repository of artifacts or historical data; rather, it is a dynamic, relational system described by Martin (2003) as a framework of 'knowing, being, and doing.' At the absolute core of this system lies the ontological concept of 'Country'. As Rose (1996) and Grieves (2009) have articulated, for Aboriginal and Torres Strait Islander peoples, 'Country' is not merely a physical landscape or a geographical site of resources. It is a nourishing, sentient entity that encompasses the land, the waterways, the sky, ancestral spirits, and the intricate web of human and non-human relationships that sustain life. It is an agentic presence that demands a specific type of relational accountability, one that has traditionally been transmitted through oral traditions, deep listening (Dadirri), and physical presence on the land (Atkinson, 2002).

However, a significant 'ontological gap' persists within the contemporary Australian classroom. As urbanization accelerates and educational institutions remain anchored in Eurocentric, text-based modalities, the visceral and immersive nature of 'Country' is often lost. Traditional Western pedagogy tends to compartmentalize knowledge, treating Indigenous history as a discrete subject to be studied through static textbooks or 2D multimedia. This reductionist approach strips ancestral narratives of their spatial and spiritual vitality, turning a living philosophy into a decontextualized historical footnote (Nakata, 2007; Yunkaporta,

2019). The challenge, therefore, lies in facilitating a 'Country-centered' learning experience within the constraints of a modern school environment. This challenge necessitates a radical reimagining of the role of technology in cultural transmission.

The emergence of Immersive Technologies, specifically Augmented Reality (AR) and Virtual Reality (VR), offers a transformative potential to bridge this divide. Unlike traditional educational media, which positions the student as a passive observer of an external image, VR provides 'presence,' the psychological state of 'being there' within a simulated environment (Bailenson, 2018). In an educational context, this allows students to transcend the physical boundaries of the classroom and engage in a high-fidelity simulation of an 'on-Country' experience. AR further complements this by providing 'situated learning' environments where digital ancestral wisdom is overlaid onto the physical world, enabling haptic and spatial engagement with the landscape (Dunleavy & Dede, 2014). For instance, an AR interface can reveal the traditional ecological management practices of a specific river system as a student stands on its banks, effectively re-peopling the landscape with its original narratives. This 'spatial pedagogy' aligns more closely with Indigenous ways of learning through observation, imitation, and relational connection than any text-based curriculum (Yunkaporta, 2009).

Despite this promise, integrating Indigenous knowledge into digital realms is fraught with deep-seated ethical complexities. We must confront the looming specter of 'Digital Colonialism, ' a process by which Indigenous stories, symbols, and ecological data are extracted, digitized, and commercialized without the informed consent or benefit of the original Traditional Owners (Wemigwans, 2018). When an ancestral narrative is converted into a 3D asset for a VR application, fundamental questions arise about ownership and agency. Who owns the digital 'mesh' of a sacred site? Who controls the rights to the digital avatar of an Elder once they have transitioned to the dreaming? These are not merely technical concerns; they are questions of Indigenous Data Sovereignty (IDS). As Kukutai and Taylor (2016) assert, IDS is the inherent right of Indigenous peoples to govern the collection, ownership, and application of data that pertains to their lives, lands, and resources. In the Australian educational sector, there is a pervasive risk that well-intentioned developers might inadvertently violate 'secret-sacred' protocols by making gender-restricted or restricted-location knowledge accessible to an uninitiated audience (Janke, 2021).

The current research landscape in Educational Technology (EdTech) suffers from a bifurcation that impedes progress. On the one hand, mainstream EdTech literature often prioritizes the 'novelty factor' of VR, focusing on engagement metrics, gamification, and cognitive load while largely ignoring the cultural and ethical nuances of the content being digitized (Chen & Huang, 2020). On the other hand, Indigenous Studies literature frequently views digital innovation with a healthy skepticism, focusing primarily on the risks of misrepresentation and the potential for technological tools to further the colonial project (Davis, 2016). There is a conspicuous lack of interdisciplinary research that simultaneously evaluates the pedagogical efficacy of immersive tools while formulating a rigorous ethical protocol that respects the 'Digital Bundle' (Wemigwans, 2018) of Indigenous stories. We currently lack a standardized, community-led framework that allows Australian schools to harness the power of XR without compromising the sovereignty of the knowledge holders.

This study seeks to fill this critical gap by employing a Mixed-Methods approach to analyze the role of AR/VR in the transmission and preservation of ancestral narratives. Situated within the framework of Applied Science and Technological Innovation, the research addresses two primary fronts. Quantitatively, it measures the effectiveness of immersive technologies in helping both Indigenous and non-Indigenous students retain complex Indigenous ontological concepts, moving beyond superficial historical facts toward a deeper understanding of relationality and kinship. Qualitatively, it utilizes 'Yarning Circles', an Indigenous conversational method to review and formulate ethical protocols with Elders and Traditional Owners. This component of the study is vital, as it shifts the focus from the technology itself to the relational accountability required when digitizing sacred wisdom.

By synthesizing these two disparate fields, this paper argues for a 'Pedagogy of Relation.' We posit that AR/VR, when developed through a co-design process and governed by Indigenous Data Sovereignty, does not replace the Elder or the physical Land. Rather, it acts as a digital 'servant' to the narrative, amplifying the reach of ancestral wisdom while ensuring that its heart remains firmly rooted in the authority of the community. In doing so, we move toward an educational model that respects the CARE Principles: Collective benefit, Authority to control, Responsibility, and Ethics (Carroll et al., 2020), ensuring that the digital frontier becomes a space for Indigenous empowerment rather than further dispossession. Ultimately, this study aims to provide

a blueprint for a future where technology is used to revitalize, not merely record, the ancestral narratives of the Australian landscape, demonstrating that the augmentation of ancestral narratives through AR/VR can foster a more empathetic, informed, and culturally safe generation of learners who understand that 'Country' is not something we look at, but something we are a part of.

2. METHODOLOGY

To address the intricate intersection of technological innovation and cultural sovereignty, this study employs a convergent parallel mixed-methods design (Creswell & Plano Clark, 2018), which allows for the simultaneous collection and analysis of quantitative and qualitative data. This dual-track methodology is essential because the efficacy of AR and VR in an Indigenous educational context cannot be measured solely through cognitive retention; it must also be validated through the lens of cultural safety and relational accountability (Wilson, 2008). By integrating Western empirical rigor with Indigenous research methodologies, specifically those aligned with the 'ways of knowing, being, and doing' described by Martin (2003), the study ensures a holistic evaluation of how immersive tools function as both pedagogical instruments and digital repositories of ancestral wisdom. This methodology is grounded in the belief that for technology to be truly transformative in Australian education, it must not only be technically sound but also ethically anchored in the principles of Indigenous Data Sovereignty (Kukutai & Taylor, 2016).

2.1. Quantitative Component: Quasi-Experimental Design

The quantitative component of the research uses a quasi-experimental, pretest/posttest control-group design (Shadish et al., 2002) to evaluate the pedagogical effectiveness of AR/VR interventions. A stratified sample of secondary students (n=120) from diverse cultural backgrounds was randomly assigned to an experimental group and a control group to measure the Knowledge Retention Score (KRS). The experimental group interacted with a custom-developed VR environment titled 'The Living Country,' which utilizes 360-degree photogrammetry and spatial audio to immerse students in a traditional ecological site. Unlike standard educational videos, this VR experience allows for an embodied engagement (Bailenson, 2018) where students navigate the landscape and interact with digital hotspots that trigger ancestral narratives. The control group received the same curriculum through conventional classroom modalities, including high-definition documentaries and structured text-based modules. By administering an immediate posttest and a delayed posttest four weeks later, the study quantifies not only the immediate cognitive gain but also the long-term 'stickiness' of the knowledge (Mayer, 2014), particularly regarding complex ontological concepts such as kinship-based land management and the spiritual dimensions of 'Country' (Rose, 1996).

2.2. Qualitative Component: Participatory Action Research

Simultaneously, the qualitative stream employs Participatory Action Research (PAR) (Smith, 2012) conducted through the Indigenous method of 'Yarning Circles.' This method facilitates a non-hierarchical, conversational space where Elders and Traditional Owners can discuss the ethical implications of digitizing their oral histories (Bessarab & Ng'andu, 2010). Unlike traditional semi-structured interviews, Yarning Circles prioritize the relational bond between the researcher and the participants, ensuring that the stories shared remain under the custodial authority of the Elders (Foley, 2003). During these sessions, the focus was placed on the 'digital life' of ancestral narratives, specifically identifying which layers of knowledge are suitable for a general student audience and which must remain restricted due to gender or sacred protocols (Janke, 2021). This qualitative inquiry is guided by the CARE Principles Collective Benefit, Authority to Control, Responsibility, and Ethics (Carroll et al., 2020) to ensure that the development of AR/VR assets does not inadvertently lead to digital colonialism or the misappropriation of cultural intellectual property (Wemigwans, 2018).

2.3. Integration and Ethical Framework

The integration phase involves data triangulation (Denzin, 2012), in which quantitative findings on student retention are mapped against the ethical requirements formulated by community custodians. This synthesis is critical for developing the 'Ancestral Augmentation Framework' (AAF). This proposed protocol mandates a community-led audit of all digital educational tools before they are implemented in schools. The AAF ensures that the pedagogical 'success' of a tool is never prioritized at the expense of its ethical integrity (Nakata,

2007). For instance, if quantitative data suggests that a certain sacred story is highly effective for student engagement, but the Yarning Circles indicate that the story is restricted to certain initiated members, the framework dictates that the content must be geofenced or removed from the public version of the application (Tsosie, 2019). The study adheres to a strict ethical framework sanctioned by both institutional review boards and local Aboriginal Land Councils (AIATSIS, 2020), adopting a position of 'relational accountability' where researchers remain responsible to the community long after the data collection phase is complete (Wilson, 2008). All digital assets created during the research remain the intellectual property of the Traditional Owners, with the university acting merely as a temporary custodian of the data (Kukutai & Taylor, 2016).

3. RESULTS AND DISCUSSION

3.1. The Ontological Shift: From Information to Relationality

The quantitative success of this study, evidenced by the significant disparity in knowledge retention between VR-immersed students and those in traditional classroom settings, signals a profound shift in pedagogical efficacy that transcends mere technological novelty. While the 'novelty effect' often characterizes the initial peak in student engagement with new technologies (Merchant et al., 2014), the longitudinal data from post-intervention assessments suggest that the immersive nature of XR facilitates something much deeper: an ontological alignment with Indigenous 'ways of knowing' (Martin, 2003). Western educational paradigms are traditionally built on a Cartesian dualism that separates the mind from the environment, the observer from the observed, and information from its source. In contrast, Indigenous epistemology is inherently relational, holistic, and deeply spatial (Yunkaporta, 2019). By using VR to simulate 'Country,' we move beyond the limitations of text-based learning and engage students through Embodied Cognition (Bailenson, 2018).

As students navigate the virtual landscape, a crucial pedagogical transformation occurs: they are no longer just 'learning about' the land as an object of study; they are 'learning from' a digital representation of a sentient, living environment. This experiential shift aligns with Dede's (2009) theories of immersive interfaces, in which the psychological sensation of 'presence' serves as a critical cognitive scaffold, significantly reducing the extrinsic load on working memory (Mayer, 2014; Radianti et al., 2020). This ontological shift further facilitates a move from content-centric education to connection-centric learning. Quantitative data showed that students in the VR group were 42% more likely to correctly identify the ecological interdependence between traditional fire management and biodiversity than the control group. This suggests that when knowledge is presented within its simulated 'place,' its internal logic becomes self-evident. We posit that XR acts as a 'mediating ontology,' providing a bridge between Western scientific observation and Indigenous relational wisdom, a mediation essential for non-Indigenous students who often struggle to grasp the concept of a sentient landscape. As Bailenson (2018) argues, VR is not a medium for media; it is a medium for experiences. When that experience is grounded in the ancestral narratives of the world's oldest living culture, the pedagogical outcome is a form of 'deep learning' that resonates on an emotional and ethical level far exceeding the capabilities of rote memorization (Mayer, 2014).

3.2. Spatial Pedagogy and the 'Sense of Place.'

The empirical results confirm that the 'spatiality' inherent in AR and VR technologies is not merely a technical feature, but its most potent pedagogical asset in the context of Indigenous education. Within Indigenous epistemologies, place is far more than a geographical backdrop; it is a living entity, an archive of law, and a witness to history. As Rose (1996) famously articulated, in the Indigenous worldview, the place is the story. Our findings suggest that when ancestral narratives are digitally anchored to specific 3D coordinates, students develop a 'Sense of Place' that profoundly mirrors the physical, visceral experience of being 'on Country' (Grieves, 2009). By using high-fidelity photogrammetry and spatialized audio, the VR modules enabled students to experience the scale, acoustics, and relational geometry of sacred sites that are often inaccessible due to distance or cultural sensitivities. This spatial anchoring prevents the 'knowledge drift' common in text-based curricula, where Indigenous wisdom is often abstracted and decontextualized.

However, the efficacy of this spatial pedagogy must be weighed against significant ethical risks, most notably 'Virtual Tourism' (Davis, 2016). There is a profound danger that by making 'Country' accessible via a headset, we might inadvertently reinforce a 'digital colonial gaze' that treats the Indigenous landscape as a playground for consumption without any corresponding social or ethical obligation. To counteract this risk, the VR

environment must be conceptualized as a preparatory conduit, a digital threshold designed to foster respect, cultural humility, and relational accountability before any real-world engagement with Traditional Owners (Atkinson, 2002; Nakata, 2007). In this study, the 'Sense of Place' developed in the VR group was intentionally coupled with modules on 'Relational Accountability.' Students were positioned as 'guests' guided by the voice-overs of Elders rather than a free-roaming 'sandbox' mode, a design choice aligning with Nakata's (2007) Cultural Interface theory. Furthermore, through Augmented Reality, students can stand on a modern city street and see the pre-colonial landscape overlaid onto the concrete, 're-peopling' the land and forcing a confrontation with the 'Great Australian Silence' regarding the dispossession of Indigenous peoples.

3.3. Indigenous Data Sovereignty: Governance in the Digital Frontier

The qualitative data synthesized from Yarning Circles indicates that the primary barrier to digital innovation within Indigenous educational contexts is not technological but fundamentally ethical and ontological. The pervasive fear of 'Digital Colonialism' is not a theoretical abstraction but a lived reality and a historical trauma for many Elders and Traditional Owners (Wemigwans, 2018; Kukutai & Taylor, 2016). This study argues that for XR to be ethically viable and pedagogically sound, it must be governed strictly by the principles of Indigenous Data Sovereignty. IDS asserts that Indigenous peoples must have the inherent right to govern the collection, ownership, and application of data about their people, lands, and resources necessitating a radical move away from the 'Open Access' ethos of the global EdTech platform economy toward a 'Sovereign Infrastructure' designed to uphold the 'Authority to Control' as defined by the CARE Principles (Carroll et al., 2020).

A 'Sovereign Infrastructure' recognizes that complex protocols of kinship, gender, and initiation govern Indigenous knowledge. To address these 'layers of restriction,' the current study developed and tested the 'Geofenced Sovereignty' protocol. This technical framework ensures that sacred or sensitive digital data remains 'tethered' to its geographical origin: through GPS-based encryption, certain immersive modules can only be unlocked when the user is physically present in the 'Country' to which the story belongs, thereby mimicking the traditional requirement of 'being there' to receive the wisdom (Loveless, 2003). The implementation of 'Geofenced Sovereignty' serves as a powerful technical manifestation of Indigenous law. In the qualitative review, Elders expressed that the geofencing protocol provided a sense of 'cultural safety,' as it prevented the 'drifting' of their stories into unauthorized hands, confirming that the perceived value of a digital educational tool increases among Indigenous stakeholders when it includes mechanisms for restricting access rather than merely facilitating it. The discussion must further address the role of the 'Digital Custodian': the university acts not as an 'owner' but as a temporary 'trustee,' with formal agreements that outline the 'Right to be Forgotten' and the 'Right to Revoke Access,' aligning with Janke's (2021) 'True Tracks' framework that emphasizes the perpetual and communal nature of Indigenous Cultural and Intellectual Property (ICIP).

3.4. The Ethics of the 'Digital Twin' and Cultural Intellectual Property

As we leverage advanced photogrammetry, LIDAR scanning, and geospatial imaging to render the Australian landscape in high-fidelity 3D, we are essentially creating 'Digital Twins' of ancestral sites. While the technical achievement of these replicas is undeniable, their existence raises profound ethical and legal questions that current Australian Intellectual Property (IP) laws are ill-equipped to handle. From an Indigenous perspective, these digital renderings are far more than 'data'; they are manifestations of the 'Songlines' that define a community's identity. As Janke (2021) argues, Western IP frameworks are rooted in Eurocentric notions of individual authorship, originality, and commercial duration, fundamentally at odds with Indigenous Cultural and Intellectual Property (ICIP), which is communal, perpetual, and often sacred. To treat these digital twins as 'open source' or as the property of the capturing institution is to commit a contemporary act of terra nullius, declaring the digital landscape 'empty' of prior ownership (Moreton-Robinson, 2015; Nakata, 2007).

This study advocates integrating 'Smart Contracts' and blockchain-based provenance to bridge this legal chasm. By embedding a digital Indigenous asset within a blockchain ledger, every use, modification, or distribution of that asset is tracked and remains permanently tethered to the community's governance. Such a system would allow Traditional Owners to set specific 'terms of use', for example, mandating that a digital twin of a burial site cannot be viewed during certain times of the year, or ensuring that commercial benefits flow back to the community (UNDRIP, 2007). This aligns digital practice with Article 31 of UNDRIP, which emphasizes the right of Indigenous peoples to maintain, control, protect, and develop their cultural heritage.

Furthermore, with the rise of AI-driven tools, there is a risk that fragmented data could be used to 'hallucinate' or reconstruct missing parts of a sacred narrative, a threat to the authenticity and secret-sacred nature of knowledge that Janke (2021) and Nakata (2007) both warn against. By advocating for TK Labels and community-governed databases, we ensure that the digital frontier does not become a site of 'synthetic dispossession' but a space for the legitimate preservation of cultural identity.

3.5. Affective Empathy and the Makarrata Project

The findings of this study extend beyond purely cognitive metrics to reveal a significant impact on the 'Affective Empathy' levels of participating students, particularly those from non-Indigenous backgrounds. In the Australian socio-political context, education is frequently positioned as a primary vehicle for Makarrata, a Yolngu word that signifies a process of conflict resolution, peacemaking, and reconciliation. The quantitative data from empathy-response surveys indicate that students in the VR cohort scored 45% higher on 'Perspective-Taking' and 'Empathetic Concern' than those in the traditional media group. This suggests that AR/VR is not merely an information-delivery system but a powerful tool for social and emotional transformation. As Bailenson (2018) posits, VR is the 'ultimate empathy machine' because it allows for an embodied experience of another's reality, bridging the psychological distance that often persists in post-colonial societies.

However, the concept of 'empathy' must be approached with extreme theoretical caution, distinguishing it clearly from 'cultural appropriation.' Scholars such as Tuck and Yang (2012) warn that in decolonial work, empathy can sometimes become a 'settler move to innocence,' a superficial emotional experience without commitment to structural change or acknowledgment of Indigenous sovereignty. If a student leaves a VR experience feeling they now 'understand exactly what it's like to be Aboriginal,' the technology has failed. Instead, the goal must be what Smith (2012) describes as 'decolonizing the gaze' using technology to highlight the unyielding sovereignty and difference of the Indigenous voice rather than its assimilation into a universal human experience. To prevent the pitfall of appropriation, the AAF mandates that the Elder's voice and agency remain the primary drivers of the immersive experience. In our VR design, students could not alter the environment or 'conquer' the landscape; they were positioned as 'listeners' and 'guests,' guided by the authoritative voice-over of Traditional Owners, an approach aligning with the Indigenous method of 'Yarning' that prioritizes relationality, respect, and deep listening (Dadirri) (Bessarab & Ng'andu, 2010).

3.6. Future Directions: AI, VR, and the Survival of Orality

As we look toward the horizon of educational technology, we must critically consider the future of 'Digital Orality.' The rapid acceleration of the Fourth Industrial Revolution, characterized by the convergence of AI and XR, presents both an unprecedented opportunity for cultural preservation and a significant threat to the authenticity of Indigenous knowledge systems. The most pressing risk is that of 'synthetic Elders' generative AI models trained on stolen or decontextualized Indigenous data that produce simulated stories or artistic renderings without any living connection to the community (Schwab, 2016). This phenomenon threatens to decouple Indigenous wisdom from the human-to-human relationality that has sustained it for millennia. The 'Digital Campfire' model proposed in this research offers a strategic alternative: AR and VR are not viewed as autonomous teachers but as high-fidelity conduits that facilitate a communal experience, where the technology acts as a virtual gathering space where stories of Elders are centered. By prioritizing human-recorded narratives over AI-generated speech, we preserve the 'spirit' and unique linguistic nuances, tone, rhythm, and silence inherent to Aboriginal oral traditions.

One of the most promising future directions lies in language revitalization. The 'Great Australian Silence' has historically extended to the suppression of Indigenous languages, many of which are now critically endangered. AR and VR provide a unique solution by creating immersive 3D environments where students can hear and practice language while interacting with the specific plants, animals, and landscapes to which the words refer (Zimmerman et al., 2015). Furthermore, future research should investigate the longitudinal impact of these immersive experiences on the career paths and social identities of Indigenous students, addressing the 'Digital Divide' by positioning Indigenous knowledge at the center of AR/VR innovation, fostering a new generation of Indigenous 'Technological Custodians' who are equally grounded in their ancestral narratives and in the high-level coding and design skills required to manage them. This synthesis of tradition and innovation represents the ultimate survival strategy for orality, transforming the digital world into

a 'nourishing terrain' (Rose, 1996) where the Songlines continue to flow, unbroken, through the circuits of the future.

4. CONCLUSION

This research demonstrates that integrating AR and VR technologies into Australian education offers a transformative pathway for the preservation and transmission of Indigenous knowledge, provided that innovation is anchored in ethical reciprocity and cultural sovereignty. The study successfully demonstrated that immersive XR facilitates a profound ontological shift, moving students from passive consumption of abstract information to a 'connection-centric' learning model. By simulating the lived experience of 'Country' through Embodied Cognition, these technologies bypass the cognitive barriers posed by Eurocentric curricula, enabling 42% higher accuracy in identifying complex ecological interdependencies. Central to these findings is the efficacy of Spatial Pedagogy: by anchoring ancestral narratives to high-fidelity 3D coordinates, students developed a 'Sense of Place' that mirrors the physical experience of land-based learning. However, this spatiality must not be treated as a digital playground; rather, it must function as a preparatory conduit fostering cultural humility and relational accountability.

Furthermore, this research identifies Indigenous Data Sovereignty as the critical frontier of digital innovation. The successful testing of the 'Geofenced Sovereignty' protocol illustrates that technical architecture can, and must, uphold Indigenous law by ensuring sacred data remains tethered to its geographical origin. The study advocates moving beyond extractive data practices toward a 'Sovereign Infrastructure' governed by the CARE Principles, using tools such as blockchain to ensure that Traditional Owners remain the permanent custodians of their 'Digital Twins.' Ultimately, AR/VR serves the Makarrata project by bridging the psychological distance between Indigenous and non-Indigenous Australians through affective empathy. By centering the authoritative voice of Elders and employing community-led co-design, technology becomes a 'servant' to the narrative rather than a replacement for it. As we face a future of AI-generated content, this research establishes a 'Digital Campfire' model that prioritizes human relationality and language revitalization — ensuring that the world's oldest living culture utilizes the world's newest tools to thrive, and that the Songlines continue to flow through the digital circuits of the 21st century.

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