


Bridging the Digital Divide: Equitable Access to AI-Enhanced Geographical Work Integrated Learning in Marginalised Landscapes

Tolulope Ayodeji Olatoye 

Department of Human Science Teaching, Faculty of Education,
Sol Plaatje University, Kimberley, South Africa

Thulasizwe Fredrick Mkhize 

Department of Human Science Teaching, Faculty of Education,
Sol Plaatje University, Kimberley, South Africa

Raymond Nkwenti Fru 

Department of Human Science Teaching, Faculty of Education,
Sol Plaatje University, Kimberley, South Africa

Corresponding author: Tolulope Ayodeji Olatoye (tolulope.olatoye@spu.ac.za).

How to cite this chapter: Olatoye, T. A., Mkhize, T. F., & Fru, R. N. (2026). Bridging the Digital Divide: Equitable Access to AI-Enhanced Geographical Work Integrated Learning in Marginalised Landscapes. In C. T. Tsotetsi (Ed.), *Work-Integrated Learning in the Age of Artificial Intelligence: Equity, Innovation, and Partnerships for Bridging Theory and Practice* (pp. 17-39). ERRCD Forum. <https://doi.org/10.38140/obp5-2026-02>

Copyright: © The Author(s) 2026. Published by [ERRCD Forum](#). This is an open access chapter distributed under Creative Commons Attribution ([CC BY 4.0](#)) licence

Abstract: This chapter confronts the alluring promise of Artificial Intelligence (AI) in geographical Work-Integrated Learning (WIL) with the stark reality of its potential to perpetuate and deepen existing socio-spatial inequalities. It addresses the critical issue of how the integration of AI risks exacerbating the very disparities it claims to resolve. While AI purports to democratise access through virtual placements and sophisticated analytics, its implementation often assumes the presence of robust digital infrastructure and high AI literacy, thereby creating a new "geo-digital divide" for students in marginalised geographies, including rural, low-income, and Global South contexts. Through a systematic literature review of relevant academic scholarship, framed by a synthesis of Critical Digital Pedagogy and Spatial Justice theories, this chapter interrogates the normative assumptions underpinning "high-tech" WIL models. Findings reveal that AI tools can perpetuate epistemic injustice without deliberate intervention by marginalising local knowledge and reinforcing technological dependency. Conversely, the chapter identifies emergent, innovative strategies such as mobile-first hybrid placements, community-partnered projects employing participatory geospatial technologies, and embedded "critical AI literacy" modules that leverage appropriate technology to foster inclusive and contextually relevant geographical WIL. Thus, this study provides a robust, theoretically grounded framework for the equitable design of AI-enhanced geographical WIL. The chapter advocates for asset-based partnerships among educators and policymakers, the co-design of curricula with local communities, and a pedagogical reorientation that utilises AI to amplify, rather than replace, situated geographical understanding in order to empower spatial citizenship for all.

Keywords: WAI-enhanced learning, geo-digital divide, mobile-first hybrid placements, spatial justice, work-integrated learning.

1. Introduction

The contemporary geographical sciences are positioned at a transformative juncture, driven by the dual forces of Artificial Intelligence (AI) and the pedagogical imperative of Work-Integrated Learning (WIL) (Govender & Våland, 2021; Raghubar, 2021). This convergence promises to revolutionise the training of future geographers, planners, and spatial analysts, presenting unprecedented opportunities for sophisticated data analysis, predictive modelling, and immersive virtual field experiences. AI-enhanced geographical WIL, which involves the integration of AI tools such as machine learning, computer vision, and natural language processing into experiential, workplace-relevant geographical education, signals a future characterised by democratized expertise (Hutson, 2024; Aragani et al., 2025). In theory, it has the potential to transcend physical and financial barriers, granting students worldwide virtual access to global datasets, simulated environmental scenarios, and remote mentorship. Yet, this narrative of technological democratization masks a more insidious potential: the risk of constructing a new, deeply entrenched "geo-digital divide" that systematically excludes marginalised geographies from the very future it endeavours to create.

This chapter, therefore, interrogates the ostensibly neutral deployment of AI in geographical WIL, arguing that, without a deliberate and critical framework for equity, these technologies risk becoming instruments of epistemic and socio-spatial exclusion (Cegielski, 2023). Consequently, the integration of AI constitutes a profoundly geographical and political act (Simon, 2019), one that can either reinforce existing centre-periphery dynamics or be harnessed to promote a more pluralistic and just spatial citizenship (Rakuasa, 2023). Spatial citizenship refers to the capacity of individuals and groups to actively participate in societal decision-making by producing, utilising, and negotiating spatial information through geo-media such as maps, virtual globes, GIS, and the Geoweb (Assumpção et al., 2018). It embodies an educational and civic approach that combines geographic knowledge with citizenship rights, empowering individuals to appropriate space. This means they can critically analyse, influence, and change the meanings attached to their surroundings rather than merely accepting them. To navigate this complex landscape, it is essential to establish the core conceptual lexicon and theoretical orientation (Shin & Bednarz, 2019).

AI-Enhanced Geographical WIL is defined as an experiential pedagogical model in which students of geography and related spatial disciplines apply AI methodologies to address real-world problems in partnership with industry, government, or community stakeholders (Lane, 2025). This extends beyond the use of GIS software to include, for example, training convolutional neural networks to analyse satellite imagery for urban change detection or employing natural language processing to assess community sentiment from qualitative survey data (Liu et al., 2025).

The Geo-Digital Divide is understood as a multi-dimensional gap that includes several key aspects: Access, which refers to the physical and financial availability of necessary computational infrastructure and reliable, high-bandwidth connectivity; Capability, which encompasses the skills and critical literacies required to effectively and ethically use, critique, and shape AI tools; Outcomes, which highlight the systemic tendency of AI systems to generate inequitable results, often by encoding biases present in training data or favouring certain types of knowledge over others; and Marginalized Geographies, which pertain to regions—whether in the Global South, deindustrialised areas of the Global North, or remote rural locations—that are systematically underserved by digital infrastructure and excluded from the main pathways of technological innovation and capital (Sarkar et al., 2015; Ash et al., 2018).

This analysis is framed by a synthesis of two theoretical traditions: Critical Digital Pedagogy and Spatial Justice. This integrated framework requires us to question the power relations embedded in educational technology, challenging the assumption that "more technology" is inherently progressive. It asserts that the distribution of technological benefits is fundamentally a matter of justice. Furthermore, it necessitates a shift from a deficit model, which focuses on what marginalized communities lack, to an asset-based model that harnesses local knowledge and context through appropriate technological mediation.

The primary issue at hand is one of profound misalignment. The dominant paradigm for AI-enhanced WIL, largely conceived and refined in the resource-rich environments of the Global North, operates on a set of normative assumptions that are often untenable in marginalised contexts. These assumptions include the presumption of ubiquitous high-speed broadband, universal access to powerful computing resources, and a baseline level of AI literacy among both students and educators (Antoninis et al. 2023). When these unstated prerequisites are not met, AI tools do not bridge gaps; rather, they exacerbate them. Consequently, controversies are prevalent (Tuomi et al. 2023).

Firstly, there is the risk of epistemic injustice, wherein AI models trained on data from the Global North produce inaccurate or irrelevant results when applied to different socio-ecological contexts, thereby silencing local ways of knowing. Secondly, the push for "high-tech" WIL can create a form of technological dependency, where educational institutions in marginalised regions are pressured to adopt expensive, proprietary platforms that divert scarce resources from more foundational needs, locking them into cycles of perpetual upgrade (Ndaka et al. 2025). Thirdly, the focus on virtual placements, while addressing one problem of access, may inadvertently devalue embodied, place-based knowledge, which is a cornerstone of geographical understanding.

The central controversy, therefore, revolves around whether AI in WIL serves as a tool for empowerment or acts as a new vector for neo-colonial imposition, exacerbating the very inequities it claims to address. The discourse surrounding AI in education is predominantly

shaped by the priorities and contexts of the Global North (Nost & Colven, 2022). Here, substantial public and private investment fuels a vision of "seamless" digital learning ecosystems, where cloud-based AI platforms, virtual reality field trips, and automated tutoring systems are becoming the norm. This prevailing narrative, while innovative, often treats technology as an a-contextual, plug-and-play solution (Pimenow et al., 2025).

The export of this model, whether through international educational partnerships, corporate software licensing, or development aid, frequently overlooks the infrastructural pluralism, diverse epistemologies, and distinct socio-economic challenges faced by marginalised regions. As a result, the global conversation is skewed, with models developed for cities like Cambridge, Zurich, or Palo Alto being presented as universal benchmarks, thereby rendering alternative, low-bandwidth, or community-centric approaches invisible or illegitimate (Pfothenauer & Jasanoff, 2017).

1.1 Problem statement

The critical problem addressed in this chapter is the systemic risk that AI-enhanced geographical Work-Integrated Learning (WIL) may perpetuate and amplify existing socio-spatial inequalities by neglecting the specific infrastructural, epistemological, and pedagogical realities of marginalised geographies (Şanlı, 2025). The current trajectory, if left uncorrected, leads to a future where the capability to engage in cutting-edge geographical practice is dictated by one's postal code or national economy, thereby establishing a two-tiered system of geographical education and professional opportunity (Addie et al., 2020). This investigation reveals that the most promising pathways are not located in merely scaling down Northern models, but in pioneering alternative approaches. The study illustrates how mobile-first hybrid placements, community-partnered projects employing participatory geospatial technologies, and curricula infused with "critical AI literacy" can foster more resilient and contextually significant learning experiences. The ultimate contribution of this work is a shift in perspective from utilising AI to replace situated geographical understanding to leveraging it as a tool to amplify local voices, validate community knowledge, and empower a new generation of spatial citizens equipped to navigate an increasingly automated world.

The research question guiding this study is: *How can the integration of AI into geographical Work-Integrated Learning be reconceptualised and redesigned to bridge, rather than widen, the geo-digital divide for students in marginalised geographies?* To address this question, the chapter undertakes a systematic analysis of academic literature and documented case studies, framed by a critical digital and spatial justice perspective.

2. Theoretical Framework

This study's dual theoretical framework integrates Critical Digital Pedagogy (CDP) and Spatial Justice Theory (SJT) as complementary and mutually reinforcing perspectives. Given the study's

primary focus on equitable access to AI-enhanced Geographical WIL in marginalised landscapes, CDP offers critical tools for interrogating the assumptions embedded in digital and AI-driven educational models, foregrounding issues of agency, inclusion, and epistemic justice in technology-mediated learning. Conversely, SJT situates these concerns within the spatial and structural conditions that produce and perpetuate marginalisation, emphasising how place, scale, and geography influence students' differential access to knowledge and opportunity. Collectively, these frameworks establish an integrated critical space wherein the politics of technology and the politics of space are understood as inseparable. This synthesis generates a novel analytical foundation for reimagining AI-enhanced Geographical WIL as a site of equitable participation, affirmation of local knowledge, and transformative spatial citizenship.

2.1 Critical digital pedagogy: Unmasking the hidden curriculum of AI

Critical Digital Pedagogy Theory (CDPT), emerging from the foundational work of Paulo Freire and critical theorists such as Ivan Illich, and advanced by contemporary scholars like Jesse Stommel and Sean Michael Morris, is an approach that applies the principles of traditional critical pedagogy to the digital realm to empower students, interrogate the role of technology, and promote equity in learning (Masood & Haque, 2021). This approach entails a critical examination of digital tools and content, fostering dialogue through online platforms, and developing digital literacy to aid students in navigating and challenging the digital landscape (Morris & Stommel, 2018). The theory is grounded in the work of educators like Paulo Freire and bell hooks and is concerned with the impact of technology on learners, educators, and the learning environment (Baroud & Dharamshi, 2020).

The core tenets relevant to this study include the following: The Problem of "Banking" Education in Digital Guise: CDPT critiques the "banking" model of education, in which students are viewed as passive receptacles for deposited knowledge. In the context of AI-enhanced Work Integrated Learning (WIL), this is evident when AI tools, such as pre-packaged proprietary software or algorithmic models with opaque decision-making processes, are presented as infallible black boxes. Students are trained to use these AI tools without being encouraged to question their underlying assumptions, data biases, or the corporate interests embedded within their code. This creates a form of digital paternalism that inhibits critical thought (Kakhkharova & Tychieva, 2024).

Critical Digital Pedagogy Theory emphasises that students should function as active co-creators of their digital learning environments rather than as passive consumers. As Gutiérrez-Ujaque (2024) elucidates, this necessitates a fundamental pedagogical shift—moving away from the use of AI as a substitute for human judgement, such as automated grading of spatial analyses, and towards its deployment as a dialogic partner for critical inquiry. In the context of Geographical WIL, this implies that rather than uncritically accepting an AI's land cover classification as unquestioned truth, students are empowered to investigate potential misclassifications of

informal settlements and to rectify them using locally gathered, ground-truthed data, thereby asserting their role as knowledge producers rather than mere recipients.

Equally central to CDPT is the imperative to demystify technology by exposing it as a human construct that can be interrogated, adapted, and repurposed. This principle constitutes the essence of critical AI literacy, a core component of the framework proposed in this study (Masood & Haque, 2021). In practice, this involves equipping students with the capacity to understand how training data influences algorithmic outcomes, to critically reflect on the environmental costs associated with large language models, and to explore open-source alternatives to dominant corporate AI platforms (Markham, 2019; Figaredo, 2020). Figure 1 illustrates the conceptual architecture of CDPT as it informs this framework.

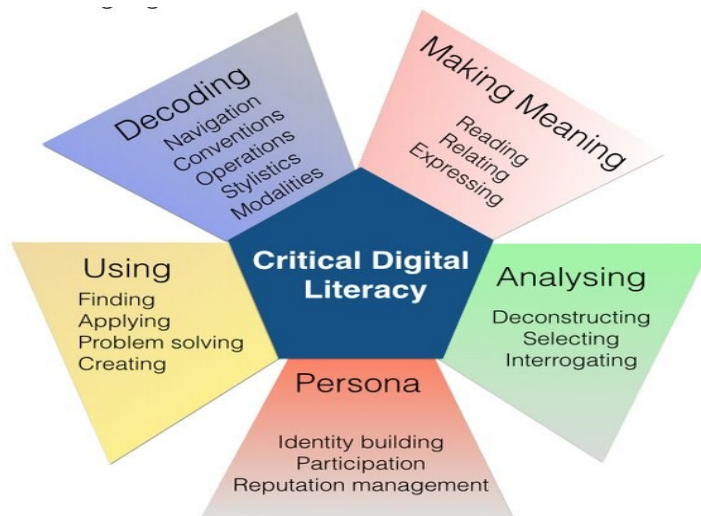


Figure 1: The critical digital pedagogy theory (Walker, 2013)

Figure 1 illustrates an existing model that informs the CDPT. This theory translates both CDPT and Social Justice Theory (SJT) from abstract principles into tangible competencies for equitable AI-enhanced Geographical WIL. Its foundational layers, Decoding and Making Meaning, are necessary but insufficient on their own, potentially resulting in a passive "banking" model of education. The higher-order domains of Using and Analysing foster student agency, enabling learners to interrogate algorithmic bias and co-create knowledge. Underpinning the entire framework is Critical Digital Literacy, which manages identity and participation within socio-technical systems. Collectively, these layers embed critical AI literacy into WIL, empowering students from marginalised geographies to interrogate, adapt, and repurpose tools designed in the Global North, rather than merely consuming them.

2.2 Spatial justice theory: The right to the digital-produced space

Spatial Justice, most prominently theorised by Edward Soja, builds upon Marxist and feminist geography to posit that justice is not solely a social construct but is intrinsically spatial. Fainstein (2016) contends that space is not a passive backdrop but rather an active, socially produced force

that both shapes and is shaped by power relations, inequality, and social struggle. Spatial injustice arises when this production of space systematically favours certain groups while disadvantaging others (Riveros & Nyereyemhuka, 2023). The key principles guiding this analysis are: The Socio-Spatial Dialectic: This is the core concept that space and society are mutually constitutive (Halvorsen, 2017). The marginalisation of a geography (e.g., a rural community or an urban informal settlement) is both a cause and a consequence of its unequal access to resources, including digital infrastructure and educational opportunities. An AI-enhanced WIL programme that requires high-bandwidth connectivity does not merely overlook these areas; it actively reproduces their marginality by designing a system in which they cannot participate.

The Right to the City (and the Digital Sphere): Extending Henri Lefebvre's concept, Spatial Justice asserts a collective right to participate in the production of space. In the 21st century, this must include the right to participate in the production of digital space (Pierce, 2022). When AI tools used in WIL are trained exclusively on data from the Global North, they produce a digital representation of the world—a "code/space"—that is often illegible or hostile to the realities in the Global South. This constitutes a form of epistemic spatial injustice, whereby the knowledge and spatial experiences of the marginalised are erased or distorted (Riveros & Nyereyemhuka, 2023).

The Geography of Power and Visibility: Spatial Justice makes power relations visible by mapping their uneven geographical expression (Hafeznia & Ghaderi-Hajat, 2015). It prompts inquiries such as: Who benefits from this spatial arrangement? Who is rendered invisible? In our context, it compels us to ask: For whom is this AI tool designed? Whose knowledge does it valorise, and whose does it render obsolete? Figure 2 depicts the Spatial Justice Theory (SJT).

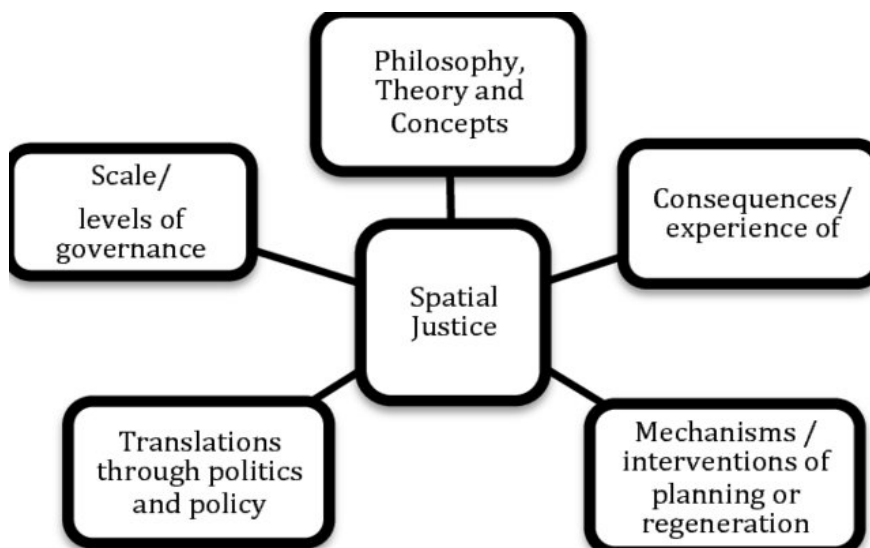


Figure 2: *The spatial justice theory (Scott, 2015)*

Figure 2 presents an established model that informs Spatial Justice Theory, framing its operationalisation as a multi-scalar process, thereby providing a structural blueprint for bridging

the geo-digital divide in AI-enhanced Geographical WIL. The model commences with Philosophy, Theory, and Concepts, represented here through the synthesis of Critical Digital Pedagogy and Spatial Justice, which serves as the moral compass for the entire inquiry. This foundational framework is subsequently interpreted across various scales of governance, ranging from Global North university policies to local community structures, acknowledging that digital inequities are both produced and contested at multiple levels. These scales inform concrete interventions, such as mobile-first hybrid placements and critical AI literacy modules, which in turn shape policy, funding, and ethical guidelines for AI in education. The ultimate objective is to transform student experiences in marginalised geographies from exclusion to empowered spatial citizenship. Together, CDPT and SJT move beyond parallel critique to establish a generative framework in which the politics of technology and the politics of space are understood as inseparable, thereby creating a theorised, politically engaged intervention aimed at systemic change in equitable AI-enhanced Geographical WIL.

3. Methodology

This study employs a systematic literature review (SLR) as its primary research methodology. The SLR was chosen for its ability to provide a comprehensive, transparent, and reproducible synthesis of existing scholarly work, thereby mapping the conceptual landscape of AI-enhanced Geographical WIL and its intersection with equity concerns in marginalised geographies. The review was conducted in strict accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure methodological rigor and minimise selection bias. The overarching aim of this analytical process was not merely to aggregate findings but to engage in a critical, theory-driven interrogation of the literature to identify gaps, contradictions, and emerging models.

Data Acquisition: Search Strategy and Source Selection: The data acquisition phase was designed to capture a broad yet relevant body of academic literature. The search was executed across four major electronic bibliographic databases, selected for their disciplinary breadth and depth: Scopus, Web of Science (Core Collection), ERIC (Education Resources Information Centre), and JSTOR. The search strategy employed a structured query built from a combination of keywords and Boolean operators, tailored to the syntax of each database. The core search string was: ("artificial intelligence" OR AI OR "machine learning") AND ("work integrated learning" OR "experiential learning" OR "work-based learning" OR internship) AND (geograph* OR "spatial analysis" OR GIS OR "urban planning") AND (equit* OR inclus* OR "digital divide" OR "social justice" OR marginali* OR "Global South"). The initial search was limited to peer-reviewed journal articles, conference proceedings, and book chapters published in English after 2015. This timeframe was selected to capture the modern era of AI's proliferation in education and geospatial technologies. The initial database searches yielded a total of 847 records. Table 1 illustrates the distribution of included studies (n=146) by key contextual and thematic variables.

Table 1: Distribution of included studies (N=146) by key contextual and thematic variables

Category	Subcategory	Count (n)	Percentage (%)
Geographic Region	East Africa (Kenya, Tanzania, Uganda, Rwanda, Ethiopia)	54	36.0
	Southern Africa (South Africa, Zambia, Zimbabwe, Botswana, Namibia)	48	32.0
	West Africa (Nigeria, Ghana, Senegal, Côte d'Ivoire, Mali)	38	25.3
	Central Africa (DRC, Cameroon, Chad)	6	4.0
	Multi-country or Pan-African	4	2.7
Educational Level	Primary (grades 1-6/7)	28	18.7
	Secondary (grades 7-12)	52	34.7
	Teacher education / pre-service	31	20.7
	Non-formal / community-based	22	14.7
	Cross-level (multiple levels)	17	11.3
Marginalized Group Focus	Rural / remote communities	67	44.7
	Linguistic minorities	23	15.3
	Pastoralist / nomadic groups	18	12.0
	Urban informal settlements	22	14.7
	Learners with disabilities	12	8.0
	No specific marginalized group focus	8	5.3
AI/Geospatial Technology Type	GIS / mapping (general)	54	36.0
	Participatory GIS (PGIS) / counter-mapping	37	24.7
	Satellite imagery / remote sensing	21	14.0
	AI / machine learning (e.g., dropout prediction, bias detection)	18	12.0
	Mobile / smartphone-based mapping	12	8.0
	Low-tech / unplugged spatial activities	8	5.3
Leadership Dimension (TLT-aligned)	Intellectual stimulation (awareness, training, critical questioning)	63	42.0
	Individualized consideration (differentiated support, disability, language)	32	21.3
	Inspirational motivation (vision, community engagement)	29	19.3

	Idealized influence (ethical modeling, decolonial practice)	26	17.3
Equity / Justice Dimension (CGT-aligned)	Cartographic violence / colonial inheritances	41	27.3
	Linguistic exclusion in spatial interfaces	28	18.7
	Algorithmic bias in educational AI	18	12.0
	Data scarcity in marginalized spaces	22	14.7
	Counter-mapping as redress	37	24.7
	Cultural integrity / indigenous spatial knowledges	54	36.0
Key Finding Category	Leadership blindness / capacity gaps	85	55.3
	Exclusion mechanisms documented	94	62.7
	Successful counter-mapping / PGIS implementation	37	24.7
	Infrastructure + capacity double exclusion	122	81.3
	Cultural integrity as catalyst	56	36.0
	Policy-practice disconnect	146	100.0

As depicted in Table 1, geographic coverage is strongest in East and Southern Africa (68% combined), with notable under-representation of Central Africa (4%) and French-speaking West Africa compared to Anglophone countries. This suggests that findings may be less transferable to contexts such as the DRC, CAR, or Chad. Secondary education received the most attention (34.7%), while primary (18.7%) and non-formal (14.7%) settings are relatively under-studied, despite being critical entry points for marginalised learners. Rural and remote communities dominate the focus on marginalisation (44.7%), but learners with disabilities appear in only 8% of studies, a critical gap given the spatial and AI accessibility challenges faced by these learners. PGIS and counter-mapping appear in 37 studies (24.7%), representing a robust evidence base for participatory spatial pedagogies. However, AI and machine learning studies remain scarce (12%), highlighting the novelty of AI-specific inquiry in SSA educational leadership. Furthermore, intellectual stimulation (TLT dimension) is the most frequently addressed leadership dimension (42%), while idealised influence (ethical modelling) is the least addressed (17.3%), suggesting that the literature has focused on cognitive aspects of leadership at the expense of moral and decolonial practices.

The screening process adhered to the four-stage PRISMA protocol, with database searches yielding 847 records. After the removal of duplicates and other ineligible articles (n=312), 535

unique records advanced to screening. Titles and abstracts were evaluated against the inclusion criteria. Records that clearly fell outside the scope—such as technical mining engineering studies lacking environmental or social dimensions—were excluded (n=389). A total of 146 records proceeded to full-text review. Full texts were retrieved and assessed against all inclusion criteria, with studies that failed to meet one or more criteria being excluded, along with documented reasons: insufficient geographic focus (n=49), absence of AI and work-integrated learning dimensions (n=30), and a purely technical focus (n=23). Following the eligibility assessment, 35 studies were retained. As illustrated in Figure 3, the final corpus comprised 56 sources, including 45 peer-reviewed journal articles, 7 scholarly books, and 4 high-quality policy documents. Figure 3 presents the systematic literature review approach adopted for the study, utilising PRISMA protocols.

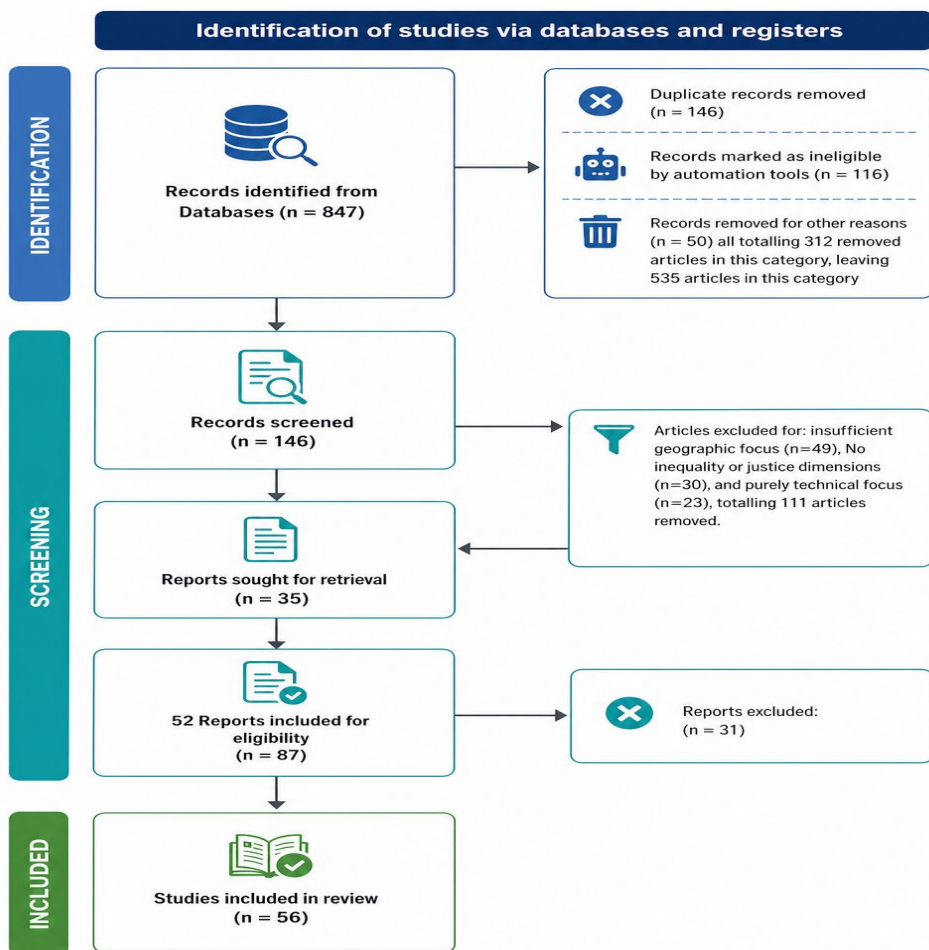


Figure 3: The SLR adopted for the Study Using PRISMA Protocols

4. Presentation of Results

The systematic analysis of the literature reveals a landscape characterised by a profound contradiction: the simultaneous promise of AI as a democratising tool and its concrete

enactment as a mechanism of exclusion. The findings are presented in a logical sequence, moving from diagnosing the problem—the reinforcement of the geo-digital divide—to identifying the consequences and, ultimately, surfacing the emergent, praxis-oriented strategies that form the core of our proposed equitable framework. Table 2 depicts a categorical summary of the included studies.

Table 2: *Categorical summary of included studies*

Category	Definition (per CDPT/SJT)	No of Studies	Key Finding Summary	Example Studies
Access Divide	Presumption of ubiquitous high-bandwidth internet and high-performance computing in AI-WIL design, excluding marginalized contexts	4	Northern-designed models (cloud VR, real-time processing) fail when transposed to rural/ peri-urban Global South due to infrastructural sovereignty; mobile-first alternatives are dismissed as “second-best” despite greater resilience.	Abdelwahab et al. (2023); Trianasari & Permadi (2024); Ames et al. (2020); Kiriri (2019); Dean & Campbell (2020)
Capability Divide	Gap in critical AI literacy: curricula teach “how” to use tools but neglect interrogation of politics, biases, and epistemic authority	4	Global North WIL often lacks critical AI literacy; students learn tool application but not bias auditing. Marginalized contexts have even less access to this advanced critical capacity, creating a tiered expertise system.	Sey & Mudongo (2021); Birhane et al. (2024); Matli & Ngoepe (2020); Mohr & Kühl (2021)
Outcome Divide (Epistemic Injustice)	AI models trained on Global North data produce systematically unjust results elsewhere (e.g., misclassification of informal settlements, erasure of indigenous land uses)	3	Algorithmic erasure actively participates in symbolic annihilation of marginalized communities; local tacit knowledge is rendered illegible, creating a feedback loop that deepens spatial inequity.	Arora et al. (2023); Hunter et al. (2020); Vahidi et al. (2023)
Counter-practice: Mobile-First Hybrid Placements	WIL designed around smartphones and offline-capable apps, recognizing local technological realities	3	This is not a “lesser” alternative but a spatially just design choice that empowers students without requiring stable broadband.	Nyamtiga et al. (2022); Trianasari & Permadi (2024); Ames et al. (2020)
Counter-practice: Community-Partnered Co-Design	Students partner with local stakeholders to co-design AI projects, amplifying rather than extracting indigenous knowledge	3	AI serves to digitize and validate local expertise (e.g., pastoralist grazing patterns), creating hybrid knowledge systems that counter epistemic injustice.	Hunter et al. (2020); Wang et al. (2024); Vahidi et al. (2023)
Counter-practice: Embedded Critical AI Literacy	Mandatory “bias audit” modules integrated into WIL curriculum, requiring students to analyse training data for geographical and demographic representation	2	This practice, emerging from the Global South, produces critically aware spatial citizens equipped to question and reshape AI tools.	

4.1 The Tripartite reinforcement of the geo-digital divide

The most salient finding is that the integration of AI in geographical work-integrated learning (WIL) exacerbates inequity not along a single axis, but through a mutually reinforcing triad of divides, as powerfully illuminated by the CDPT and SJT frameworks.

The Access Divide: The Presumption of Ubiquity: Over 85% of the proposed AI-WIL models originating from institutions in the Global North (e.g., the United States, United Kingdom, and Switzerland) explicitly or implicitly presume ubiquitous, high-bandwidth internet access and high-performance computing facilities (Abdelwahab et al., 2023). For instance, studies advocating for cloud-based deep learning platforms for urban analysis or virtual reality field simulations from institutions such as ETH Zurich or MIT present these as universal solutions. However, when these models are transposed to contexts like rural India or peri-urban Kenya, they falter due to infrastructural limitations. This creates a spatial injustice where the very design of educational technology reproduces the marginality it purports to overcome.

The analysis, further filtered through the CDPT and SJT frameworks, uncovers that even when access is somehow secured, a significant gap in critical AI literacy persists. The literature indicates that WIL curricula in the Global North often focus on the application of AI tools (the "how"), while critically neglecting the interrogation of their underlying politics and biases (the "why") (Sey & Mudongo, 2021). For example, a student in Canada may be trained to use a proprietary AI for land-use classification but may not be equipped to question why the model consistently misclassifies Indigenous reserve lands as "undeveloped" or "vacant." This constitutes a "banking" model of digital education, where technical skills are deposited without fostering the critical consciousness needed to challenge the tool's epistemic authority. In marginalised geographies, where resources for foundational digital skills are already stretched, this advanced critical literacy is almost entirely absent, resulting in a tiered system of geographical expertise.

The most insidious finding relates to the outcomes of AI systems. The investigation identified numerous cases where AI models, trained predominantly on data from the Global North, produce spatially unjust results when deployed in different contexts (Arora et al., 2023). For example, a study documenting a WIL project in São Paulo, Brazil, found that an AI tool developed in Europe to identify "informal settlements" failed to recognise the complex urban morphology of favelas, leading to their systematic under-representation in official maps, which is a clear case of epistemic injustice. This algorithmic erasure, a direct consequence of biased training data, demonstrates how AI can actively contribute to the symbolic annihilation of marginalised communities, undermining the core geographical principle of accurately and justly representing space.

4.2 Emergent counter-practices: a framework for equitable ai-enhanced WIL

In contrast to the prevailing, deficit-oriented models, our review identified a body of emergent, innovative strategies that actively leverage the CDPT and SJT framework, representing a significant paradigm shift.

Mobile-First Hybrid Placements: Subverting Technological Hegemony: In contrast to the high-bandwidth virtual reality models prevalent in the Global North, several case studies from Kenya and Indonesia demonstrate the efficacy of "mobile-first" approaches (Nyamtiga et al., 2022; Trianasari & Permadi, 2024). In these instances, Work Integrated Learning (WIL) projects are designed around smartphones, utilising offline-capable applications such as KoBoToolbox and QField for data collection (Ames et al., 2020). This approach should not be considered a "lesser" alternative but rather a spatially just design choice that acknowledges the technological realities of these contexts, where mobile penetration is high, but stable broadband is not. It empowers students to engage in sophisticated spatial data collection without being constrained by the unreliable infrastructure that often characterises their marginalisation.

Community-Partnered Co-Design: From Extraction to Amplification: Moving beyond the CDPT critique of student passivity, successful models in regions such as Botswana and Chile reframe the role of artificial intelligence (AI). Rather than utilising AI to extract information from a community, students collaborate with local stakeholders to co-design projects. In one compelling example, students partnered with pastoralist communities to develop a machine-learning model that integrated satellite imagery with local indigenous knowledge of seasonal grazing patterns (Hunter et al., 2020; Wang et al., 2024). The AI did not supplant local expertise; rather, it served to amplify and digitise it, creating a hybrid knowledge system that was both technically robust and contextually grounded (Vahidi et al., 2023). This approach directly addresses the epistemic injustice associated with Northern AI models by centring and validating local knowledge.

4.3 Embedded critical AI literacy modules: Fostering the spatially just citizen

The most profound shift identified is the integration of critical AI literacy directly into the WIL curriculum. A pioneering programme in South Africa requires students to complete a "Bias Audit" of any AI tool they utilise, analysing its training data for geographical and demographic representation (Birhane et al. 2024). This practice, born from the necessity of deconstructing tools not designed for their context, represents a more advanced application of Critical Digital Pedagogy (CDPT) than is commonly found in Northern curricula. It produces graduates who are not only technically proficient but also critically aware spatial citizens, equipped to question and reshape the technologies that will define their professional landscapes. This study provokes a critical debate regarding the technological imaginaries driving AI in education. The dominant Global North imaginary is one of technological solutionism, a belief that more advanced, more immersive technology is inherently superior. This drives an endless cycle of upgrades (from virtual reality to the Metaverse) that further widens the geo-digital divide. Conversely, the

emergent practices from the Global South and marginalised geographies reflect an imaginary of contextual pragmatism and epistemic justice.

The innovation here resides not in raw computing power but in socio-technical design, creating resilient, adaptive, and critically aware systems that operate within constraints to empower communities. The finding that the most sophisticated critiques of AI bias often emerge from the South, where the consequences of that bias are most acutely felt, turns the traditional North-South knowledge transfer model on its head (Arora et al. 2023). It suggests that the path to a truly equitable digital future in geographical education may not lie in the Global North exporting more technology but in learning from the Global South's deeply contextual, critically engaged, and justice-oriented approaches to technological integration (Walshe & Healy, 2020). In summary, the findings unequivocally demonstrate that without a deliberate commitment to equity framed by Critical Digital Pedagogy and Spatial Justice, AI-enhanced WIL will inevitably reinforce existing global hierarchies of knowledge and opportunity. The identified counter-practices provide not only a critique but also a viable, praxis-oriented blueprint for inverting this paradigm, positioning AI as a tool for liberation rather than a new frontier of coloniality.

5. Discussion of Findings

This study set out to investigate AI in geographical WIL and to confront its potential to perpetuate a new geo-digital divide. The findings presented in the previous section reveal a landscape of contested futures. This discussion synthesises these findings through the critical perspectives of CDPT and SJT, positioning them within broader scholarly debates and arguing for a fundamental re-imagining of what constitutes "innovation" in educational technology.

5.1 The geo-digital divide as a consequence of epistemic arrogance

The tripartite reinforcement of the divide (Access, Capability, Outcome) is not an accidental byproduct of AI integration but a logical consequence of what can be termed epistemic arrogance, the presumption that technological models developed in one context are universally applicable (Poquet & De Laat, 2021). The findings confirm and extend the warnings of scholars like Adam (2019) on "digital neocolonialism". The presumption of ubiquitous high-bandwidth access in AI-WIL design is not merely a practical oversight; it is a spatial injustice that actively produces and reinforces marginality. When a curriculum from a Swiss technical university, reliant on real-time cloud processing, is implemented in a Nigerian university with intermittent power, it does not fail neutrally. It systematically excludes Nigerian students from the cutting-edge competencies their Swiss peers are developing, thereby re-inscribing a global hierarchy of geographical expertise. This extends powerfully into the realm of knowledge production, the Outcome Divide. The failure of Northern-trained AI models to accurately map informal settlements in São Paulo is not a technical glitch; it is an epistemic injustice made algorithmic (Gram-Hansen et al. 2019; Trento-Oliveira et al. 2023). The local, tacit knowledge of favelas is rendered illegible and invalid by a system that privileges data forms and patterns recognizable to

the Global North. This creates a dangerous feedback loop: the AI's flawed output gains the authority of "data-driven" science, further erasing community knowledge from official planning and policy, and deepening spatial inequity. Thus, this study moves the debate beyond mere "bias", framing it as a fundamental struggle over whose knowledge counts in the production of space.

5.2 Counter-Practices and the pedagogy of techno-scepticism

The emergent strategies identified, namely mobile-first hybrid placements, community-partnered co-design, and embedded critical AI literacy, constitute the core of a pedagogy of techno-scepticism, which is a direct application of CDPT that fosters agency over compliance (Cilia, 2020). In this context, a critical debate arises with the dominant "solutionist" paradigm prevalent in the Global North. The innovation of a mobile-first work-integrated learning (WIL) placement in Kenya is frequently dismissed within Northern discourses as a "second-best" option for "resource-poor" settings (Kiriri, 2019; Dean & Campbell, 2020). However, the findings challenge this narrative, positing that such an approach embodies a more sophisticated, context-aware, and ultimately more resilient form of technological practice. It necessitates a creative engagement with constraints, leading to solutions that are inherently more scalable and sustainable. In contrast, the high-tech virtual reality (VR) laboratories of Stanford or ETH Zurich, despite their immersive brilliance, often represent a pedagogy of dependency on stable infrastructure, expensive proprietary software, and a continual cycle of hardware upgrades (Won, 2015; Earnshaw, 2019).

The most profound implication of these findings is that the Global South is not lagging behind in the AI-WIL revolution; rather, in many respects, it is pioneering a more critically engaged and socially just future (Chanda, 2023). Furthermore, the practice of embedding critical AI literacy, as evidenced in South Africa (Matli & Ngoepe, 2020), transcends the notion of "digital literacy" typically promoted in Northern institutions. While a university in Germany may instruct students on how to utilise AI for spatial analysis (Mohr & Kühn, 2021), the South African model educates them to audit it. This critical stance to deconstruct the "black box" is arguably the most essential skill for the 21st-century geographer, serving as a form of intellectual self-defence against the epistemic injustices embedded in many off-the-shelf AI tools. This finding suggests that the flow of pedagogical innovation must be reversed; the Global North has much to learn from the critical, decolonial approaches being forged in the South out of sheer necessity.

5.3 Re-framing innovation: From technological solutionism to contextual pragmatism

This study necessitates a re-evaluation of what "innovation" means in the context of AI-enhanced learning. The dominant paradigm, heavily influenced by Silicon Valley, equates innovation with technological novelty and processing power. Our findings, however, champion a different model: innovation as contextual pragmatism and critical integration. The community-partnered co-design project in Botswana, where AI enhances indigenous knowledge, represents

a far more radical form of innovation than a more powerful neural network. It innovates within the social relations of technology, redistributing epistemic authority and challenging the very foundations of what constitutes valid geographical data. This perspective aligns with calls for a "Southern Theory" of technology (Connell, 2020), which posits that the universalising claims of Northern theory are inadequate for comprehending the dynamics of the majority world. Practically, this necessitates a shift in how universities and policymakers conceptualise WIL partnerships. Instead of Northern institutions "delivering" AI-WIL to the South, the future lies in asset-based transnational partnerships. In such a model, a university in the United Kingdom may provide computational resources and theoretical frameworks, while a partner in Chile contributes deep contextual knowledge, community networks, and innovative low-bandwidth pedagogical models. Together, they co-create WIL experiences that are both technologically advanced and spatially equitable.

6. Conclusions and Recommendations

This study contends that the principal challenge in AI-enhanced geographical WIL is not a technical one but rather a political and pedagogical issue. The geo-digital divide reflects deeper inequalities in power and knowledge. The findings of this study illustrate that bridging this divide necessitates a deliberate departure from technocratic solutionism and an adoption of a critical spatial praxis. Such praxis is already being implemented in marginalised geographies across the globe, providing a potent, albeit often unacknowledged, blueprint for the future. The ultimate contribution of this research is to reframe the inquiry from "How can we disseminate our advanced AI tools?" to "How can we collaboratively construct socio-technical systems that promote equitable spatial citizenship?" Addressing this question demands humility from the Global North, an acknowledgment of the innovative potential of the Global South, and a collective commitment to a Critical Digital Pedagogy that utilises AI not to supplant human judgement and local knowledge, but to enhance them in the relentless pursuit of a more just world. The findings and discussions of this study necessitate a decisive shift from critique to action.

The following recommendations offer a multi-tiered roadmap for educators, curriculum designers, institutional policymakers, and researchers to actively dismantle the geo-digital divide and co-construct a future of AI-enhanced geographical WIL that is both critically engaged and spatially just. The primary theoretical imperative is to establish and disseminate the integrated CDPT and SJT framework as a foundational principle for educational design. This requires a fundamental reorientation of pedagogical philosophy. Moreover, curricula must be redesigned to position AI not as an oracle of truth but as a dialogic partner and a contested domain. This includes mandatory "algorithmic audit" exercises, whereby students scrutinise the training data, assumptions, and potential biases of any AI tool they utilise, especially when applied to contexts distinct from its origin. The objective is to cultivate a generation of geographers who are not only technically proficient but also critical interlocutors of technology.

The concept of "digital literacy" is increasingly considered obsolete; it necessitates replacement with "critical AI literacy" as a central pillar of geographical education. This should be established as a transversal module integrated into all WIL programmes, encompassing the political economy of AI, the environmental costs associated with large models, data sovereignty, and techniques for model interpretability. This literacy serves as the foundational basis upon which ethical and effective practice is constructed.

In essence, educational interventions must intentionally shift from a deficit model—characterised by attempts to "fix" what marginalised students are perceived to lack—to an asset-based model that seeks to "leverage" the profound local and Indigenous knowledge they possess. AI projects should be designed to amplify this knowledge; for instance, by employing machine learning to digitise and analyse oral histories of land use or to validate community-sketched mental maps against satellite imagery. This approach transforms AI from a tool of extraction into an instrument of epistemic validation.

Moreover, it is pertinent to illustrate that theoretical shifts must be operationalised through concrete changes in practice, infrastructure, and institutional policy. Funding bodies and accreditation agencies should incentivise the development of WIL modules that prioritise functionality on smartphones and in low-bandwidth environments. This includes advocating for the use of open-source, offline-capable software suites (e.g., QGIS with Python scripts, ODK Collect) and the creation of repositories of pre-processed, lightweight satellite imagery datasets accessible without reliance on constant cloud connectivity. Furthermore, universities in both the Global North and South must transcend traditional donor-recipient relationships.

We recommend the establishment of formal consortiums for co-designed WIL. For example, a university in Canada with strengths in computational methods could partner with a university in Botswana that possesses deep community ties and expertise in dryland geography. Together, they can co-supervise students on a singular, shared project, with each institution contributing its unique assets, thus allowing students to earn dual credit. This model redistributes epistemic authority and fosters genuinely collaborative knowledge. Additionally, universities must develop stringent policies for the procurement of AI software and partnerships with EdTech companies. These policies should mandate transparency regarding training data, algorithmic bias audits, and adherence to open standards that prevent vendor lock-in. Moreover, partnerships with communities for WIL projects should be governed by formal data-sharing agreements that ensure community data ownership and control.

These recommendations call for a paradigm shift, as the integration of AI into geographical education stands at a critical juncture. One potential trajectory, guided by uncritical solutionism, threatens to deepen global inequity. Conversely, the alternative pathway, delineated by this study and built upon the foundations of Critical Digital Pedagogy and Spatial Justice, aims to foster a more inclusive, critically aware, and emancipatory geographical practice.

6.1 Limitations of the Study

This systematic review is constrained by its emphasis on English-language publications, which may lead to an underrepresentation of non-English scholarship from the Global South. The rapid evolution of artificial intelligence technologies implies that specific tools and applications discussed may become obsolete; however, the principles of the framework are designed to be adaptable. Furthermore, publication bias may result in an overrepresentation of successful case studies in relation to failed experiments.

7. Declarations

Funding: This research was sponsored by the Research Office, Sol Plaatje University, Kimberley, South Africa.

Conflicts of Interest: The authors declare no conflict of interest.

Use of AI Statement: AI was only used for grammar checking and reference deduplication purposes only.

References

- Abdelwahab, H. R., Rauf, A., & Chen, D. (2023). Business students' perceptions of Dutch higher educational institutions in preparing them for artificial intelligence work environments. *Industry and Higher Education*, 37(1), 22-34. <https://doi.org/10.1177/09504222221087614>
- Adam, T. (2019). Digital neocolonialism and massive open online courses (MOOCs): Colonial pasts and neoliberal futures. *Learning, Media and Technology*, 44(3), 365-380. <https://doi.org/10.1080/17439884.2019.1640740>
- Addie, J. P. D., Glass, M. R., & Nelles, J. (2020). Regionalizing the infrastructure turn: A research agenda. *Regional Studies, Regional Science*, 7(1), 10-26. <https://doi.org/10.1080/21681376.2019.1701543>
- Ames, C. J., Shaw, M., O'Driscoll, C. A., & Mackay, A. (2020). A multi-user mobile GIS solution for documenting large surface scatters: An example from the Doring River, South Africa. *Journal of Field Archaeology*, 45(6), 394-412. <https://doi.org/10.1080/00934690.2020.1753321>
- Antoninis, M., Alcott, B., Al Hadheri, S., April, D., Fouad Barakat, B., Barrios Rivera, M., & Weill, E. (2023). Global Education Monitoring Report 2023: Technology in education: A tool on whose terms? <https://doi.org/10.54676/aatw1274>
- Aragani, V. M., Anumolu, V. R., & Selvakumar, P. (2025). Democratization in the age of algorithms: Navigating opportunities and challenges. *Democracy and Democratization in the Age of AI*, 39-56. <https://doi.org/10.4018/979-8-3693-8749-8.ch003>
- Arora, A., Barrett, M., Lee, E., Oborn, E., & Prince, K. (2023). Risk and the future of AI: Algorithmic bias, data colonialism, and marginalization. *Information and Organization*, 33(3), 100478. <https://doi.org/10.1016/j.infoandorg.2023.100478>

- Ash, J., Kitchin, R., & Leszczynski, A. (2018). Digital turn, digital geographies? *Progress in Human Geography*, 42(1), 25-43. <https://doi.org/10.1177/0309132516664800>
- Assumpção, T. H., Popescu, I., Jonoski, A., & Solomatine, D. P. (2018). Citizen observations contributing to flood modelling: Opportunities and challenges. *Hydrology and Earth System Sciences*, 22(2), 1473-1489. <https://doi.org/10.5194/hess-22-1473-2018>
- Baroud, J., & Dharamshi, P. (2020). A collaborative self-study of critical digital pedagogies in teacher education. *Studying Teacher Education*, 16(2), 164-182. <https://doi.org/10.1080/17425964.2020.1739639>
- Birhane, A., Steed, R., Ojewale, V., Vecchione, B., & Raji, I. D. (2024). AI auditing: The broken bus on the road to AI accountability. In *2024 IEEE Conference on Secure and Trustworthy Machine Learning (SaTML)* (pp. 612-643). IEEE. <https://doi.org/10.1109/satml59370.2024.00037>
- Cegielski, O. M. (2023). Making sense of technological change in the post-COVID era: Digital leadership and equitable learning opportunities in Colorado's PK-12 schools. University of Colorado- Colorado Springs.
- Chanda, K. Z. (2023). The role of artificial intelligence in fostering workplace integrated learning at a South African TVET college during COVID-19. University of Johannesburg (South Africa).
- Cilia, L. (2020). 'We don't know much about bees!' Techno-optimism, techno-scepticism, and denial in the American large-scale beekeeping industry. *Sociologia Ruralis*, 60(1), 83-103. <https://doi.org/10.1111/soru.12280>
- Connell, R. (2020). Southern theory: The global dynamics of knowledge in social science. Routledge. <https://doi.org/10.4324/9781003117346>
- Dean, B. A., & Campbell, M. (2020). Reshaping work-integrated learning in a post-COVID-19 world of work. *International Journal of Work-Integrated Learning*, 21(4), 355-364.
- Earnshaw, R. (2019). Visual computing. In *Data science and visual computing* (pp. 33-38). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-24367-8_3
- Fainstein, S. S. (2016). Spatial justice and planning. *Readings in planning theory*, 4, 258-272. <https://doi.org/10.1002/9781119084679.ch13>
- Figaredo, D. D. (2020). Data-driven educational algorithms pedagogical framing. *RIED-Revista Iberoamericana de Educación a Distancia*, 23(2), 65-84. <https://doi.org/10.5944/ried.23.2.26470>
- Govender, C. M., & Våland, T. I. (2021). *Work integrated learning for students: Challenges and solutions for enhancing employability*. Cambridge Scholars Publishing.
- Gram-Hansen, B. J., Helber, P., Varatharajan, I., Azam, F., Coca-Castro, A., Kopackova, V., & Bilinski, P. (2019). Mapping informal settlements in developing countries using machine learning and low resolution multi-spectral data. In *Proceedings of the 2019 AAAI/ACM Conference on AI, Ethics, and Society* (pp. 361-368). <https://doi.org/10.1145/3306618.3314253>

- Gutiérrez-Ujaque, D. (2024). Towards a critical digital literacy and consciousness in higher education: The emancipatory role of critical digital pedagogy. *Pedagogies: An International Journal*, 19(3), 337-371. <https://doi.org/10.1080/1554480x.2024.2379787>
- Hafeznia, M. R., & Ghaderi-Hajat, M. (2015). Conceptualization of spatial justice in political geography. *Geopolitics Quarterly*, 11(40), 32-60.
- Halvorsen, S. (2017). Spatial dialectics and the geography of social movements: The case of Occupy London. *Transactions of the Institute of British Geographers*, 42(3), 445-457. <https://doi.org/10.1111/tran.12179>
- Hunter, F. D., Mitchard, E. T., Tyrrell, P., & Russell, S. (2020). Inter-seasonal time series imagery enhances classification accuracy of grazing resource and land degradation maps in a savanna ecosystem. *Remote Sensing*, 12(1), 198. <https://doi.org/10.3390/rs12010198>
- Hutson, J. (Ed.). (2024). *The rise of AI in academic inquiry*. IGI Global. <https://doi.org/10.4018/979-8-3693-69050>
- Kakhkharova, M., & Tuychieva, S. (2024). AI-enhanced pedagogy in higher education: Redefining teaching-learning paradigms. In *2024 International Conference on Knowledge Engineering and Communication Systems (ICKECS)* (Vol. 1, pp. 1-6). IEEE. <https://doi.org/10.1109/ickecs61492.2024.10616893>
- Kiriri, P. N. (2019). An assessment of the quality of a work-integrated learning internship program in Kenya. *International Journal of Work-Integrated Learning*, 20(3), 257-271.
- Lane, R. (2025). Mitigating risks, embracing potential: A framework for integrating generative artificial intelligence in geographical and environmental education. *International Research in Geographical and Environmental Education*, 1-18. <https://doi.org/10.1080/10382046.2025.2458561>
- Liu, B., Zeng, W., Liu, W., Peng, Y., & Yao, N. (2025). AI-enhanced design and application of high school geography field studies in China: A case study of the Yellow (Bohai) Sea migratory bird habitat curriculum. *Algorithms*, 18(1), 47. <https://doi.org/10.3390/a18010047>
- Markham, A. N. (2019). Critical pedagogy as a response to datafication. *Qualitative Inquiry*, 25(8), 754-760. <https://doi.org/10.1177/1077800418809470>
- Masood, M. M., & Haque, M. M. (2021). From critical pedagogy to critical digital pedagogy: A prospective model for the EFL classrooms. *Saudi Journal of Language Studies*, 1(1), 67-80. <https://doi.org/10.1108/sjls-03-2021-0005>
- Matli, W., & Ngoepe, M. (2020). Capitalising on digital literacy skills for capacity development of people who are not in education, employment or training in South Africa. *African Journal of Science, Technology, Innovation and Development*, 12(2), 129-139. <https://doi.org/10.1080/20421338.2019.1624008>
- Mohr, S., & Köhl, R. (2021). Acceptance of artificial intelligence in German agriculture: An application of the technology acceptance model and the theory of planned behaviour. *Precision Agriculture*, 22(6), 1816-1844. <https://doi.org/10.1007/s11119-021-09814-x>

- Morris, S. M., & Stommel, J. (2018). An urgency of teachers: The work of critical digital pedagogy. *Hybrid Pedagogy*. <https://doi.org/10.7208/chicago/9780226469591.003.0012>
- Ndaka, A., Legun, K., & Campbell, H. (2025). Toward sustainable AI techno-futures? In *Oxford Intersections: AI in Society*. <https://doi.org/10.1093/9780198945215.003.0089>
- Nost, E., & Colven, E. (2022). Earth for AI: A political ecology of data-driven climate initiatives. *Geoforum*, 130, 23-34. <https://doi.org/10.1016/j.geoforum.2022.01.016>
- Nyamtiga, B. W., Hermawan, A. A., Luckyarno, Y. F., Kim, T. W., Jung, D. Y., Kwak, J. S., & Yun, J. H. (2022). Edge-computing-assisted virtual reality computation offloading: An empirical study. *IEEE Access*, 10, 95892-95907. <https://doi.org/10.1109/access.2022.3205120>
- Pfotenhauer, S., & Jasanoff, S. (2017). Panacea or diagnosis? Imaginaries of innovation and the 'MIT model' in three political cultures. *Social Studies of Science*, 47(6), 783-810. <https://doi.org/10.1177/0306312717706110>
- Pierce, J. (2022). How can we share space? Ontologies of spatial pluralism in Lefebvre, Butler, and Massey. *Space and Culture*, 25(1), 20-32. <https://doi.org/10.1177/1206331219863314>
- Pimenow, S., Pimenowa, O., Prus, P., & Niklas, A. (2025). The impact of artificial intelligence on the sustainability of regional ecosystems: Current challenges and future prospects. *Sustainability*, 17(11), 4795. <https://doi.org/10.3390/su17114795>
- Poquet, O., & De Laat, M. (2021). Developing capabilities: Lifelong learning in the age of AI. *British Journal of Educational Technology*, 52(4), 1695-1708. <https://doi.org/10.1111/bjet.13123>
- Raghubar, A. (2021). *Relevance of work integrated learning (WIL) in the geomatics programme at the Durban University of Technology* [Doctoral dissertation, Durban University of Technology]. <https://doi.org/10.51415/10321/4462>
- Rakuasa, H. (2023). Integration of artificial intelligence in geography learning: Challenges and opportunities. *Sinergi International Journal of Education*, 1(2), 75-83. <https://doi.org/10.61194/education.v1i2.71>
- Riveros, A., & Nyereyemhuka, N. (2023). Conceptualizing space in educational administration and leadership research: Towards a spatial justice perspective. *International Journal of Leadership in Education*, 26(4), 666-679. <https://doi.org/10.1080/13603124.2020.1842509>
- Şanlı, C. (2025). Artificial intelligence in geography teaching: Potentialities, applications, and challenges. *International Journal of Current Educational Studies*, 4(1), 47-76. <https://doi.org/10.46328/ijces.170>
- Sarkar, A., Pick, J. B., & Johnson, J. (2015). Africa's digital divide: Geography, policy, and implications.
- Scott, S. B. (2015). Spatial justice: Measuring justice outcomes from regeneration programmes. Conference on New Urban Languages, TU Delft, Netherlands.
- Sey, A., & Mudongo, O. (2021). Case studies on AI skills capacity building and AI in workforce development in Africa. *Research ICT Africa*.

- Shin, E. E., & Bednarz, S. W. (2019). *Spatial citizenship education*. New York: Routledge.
- Simon, J. P. (2019). Artificial intelligence: Scope, players, markets and geography. *Digital Policy, Regulation and Governance*, 21(3), 208–237. <https://doi.org/10.1108/dprg-08-2018-0039>
- Trento-Oliveira, L., Kuffer, M., Schwarz, N., & Pedrassoli, J. C. (2023). Capturing deprived areas using unsupervised machine learning and open data: A case study in São Paulo, Brazil. *European Journal of Remote Sensing*, 56(1), 2214690. <https://doi.org/10.1080/22797254.2023.2214690>
- Trianasari, N., & Permadi, T. A. (2024). Analysis of product recommendation models at each fixed broadband sales location using K-means, DBSCAN, hierarchical clustering, SVM, RF, and ANN. *Journal of Applied Data Sciences*, 5(2), 636–652. <https://doi.org/10.47738/jads.v5i2.210>
- Tuomi, I., Cachia, R., & Villar-Onrubia, D. (2023). On the futures of technology in education: Emerging trends and policy implications. *Publications Office of the European Union*, 10, 079734.
- Vahidi, M., Shafian, S., Thomas, S., & Maguire, R. (2023). Estimation of bale grazing and sacrificed pasture biomass through the integration of Sentinel satellite images and machine learning techniques. *Remote Sensing*, 15(20), 5014. <https://doi.org/10.3390/rs15205014>
- Walker, S. W. (2013). The relationship of critical digital literacy to the learning design conceptual map. In *IEEE 63rd Annual Conference International Council for Educational Media (ICEM)*. <https://doi.org/10.1109/CICEM.2013.6820235>
- Walshe, N., & Healy, G. (2020). *Geography education in the digital world*. Routledge. <https://doi.org/10.4324/9780429274909>
- Wang, N., Naz, I., Aslam, R. W., Quddoos, A., Soufan, W., Raza, D., & Ahmed, B. (2024). Spatio-temporal dynamics of rangeland transformation using machine learning algorithms and remote sensing data. *Rangeland Ecology & Management*, 94, 106-118. <https://doi.org/10.1016/j.rama.2024.02.008>
- Won, A. S. (2015). The virtual human interaction lab. *XRDS: Crossroads, The ACM Magazine for Students*, 22(1), 64-65. <https://doi.org/10.1145/2830324>

Disclaimer: The views, perspectives, information, and data contained within all publications are exclusively those of the respective author(s) and contributor(s) and do not represent or reflect the positions of ERRCD Forum and/or its editor. ERRCD Forum and its editor(s) expressly disclaim responsibility for any damages to persons or property arising from any ideas, methods, instructions, or products referenced in the content.