

Geographies of AI: urgent need for educational strategies

With the advent of ChatGPT in October 2022, artificial intelligence (AI) has entered the public consciousness, forcing engagement with its inevitable impact on various aspects of life, including academic work. This editorial takes up some environmental, social, and economic sustainability concerns associated with AI, particularly within the realm of critical pedagogy-oriented environmental education. Energy and water consumption, environmental degradation from resource extraction, and geographic disparities in labor markets are identified as pressing issues. The need to integrate these and other AI-related sustainability concerns into educational programs is highlighted, to prepare people and societies for a future where AI is ubiquitous. Similarly, greater integration of educational considerations into geographic research on AI is needed, including importantly critical geography.

Keywords: geographies of AI, sustainable AI, AI in environmental education

Introduction

The launch of the first openly available version of ChatGPT in October 2022 opened the eyes of many people to artificial intelligence (AI) as a reality. Or perhaps it is fairer to say that it has forced people to accept that they can no longer distance themselves from this technology and are forced to begin to engage with it. The impact of AI on various everyday processes, as well as on broader issues, is inevitable and has become increasingly visible in the first months of 2025, following Donald Trump's rise to power in the United States, in partnership with Elon Musk, and the release of the Chinese chatbot DeepSeek-R1. This impact includes our scholarly work as researchers and teachers.

In the area of my own chair, critical pedagogy oriented environmental education, AI developments connect with many well-known environmental, social and economic sustainability concerns. Transformative education research has identified the overconsumption of energy, water, and raw materials as key environmental concerns for a long time, which are all central to AI technology (e.g. Mathie & Wals 2022). Data centers require energy and cooling water both for the continuous training of AI models and to their use — a lot. Offering an estimate of how much that will be, even in a couple of years from now, is challenging. One estimate is that AI will use over 30% of the world's total energy consumption by 2030, but the quickly developing language models suggest that energy needs may become even greater (Bolón-Canedo *et al.* 2024). Moreover, the data centers that contribute significantly to local carbon emissions are often located in regions with cheaper electricity and other resources such as water supplies. Hence, while some regions are more burdened by the environmental costs of AI, others are reaping the economic benefits without the same environmental impact.

The global supply chains involved in producing AI hardware are another highly problematic environmental issue. The increasing demand for raw materials is of course an environmental problem in itself, as is the disposal of electronic waste, which disproportionately affects certain regions. In addition, the extraction of raw materials often leads to environmental degradation, especially in the Global South, where most mining takes place and where environmental governance is weaker than in the Global North. Mining companies tend to be multinational, with headquarters far from the mining site. The people who work in the supply chains are therefore very diverse, as are the natural environments in which they live.

In terms of social and economic sustainability, geographic disparities in labor markets are perhaps the most pressing issue. The ubiquity of AI will have a major impact on what kind of human labor is needed, and what the value of each type of human labor is relative to technological alternatives. These changes will occur everywhere, but they will play out differently in societies and local communities with different economic structures. Another important issue is the workforce needed to maintain and develop AI technologies. The need for both highly skilled and manual labor is increasing, and this work is already being done as part of the colonial world order. The risks of increasing labor inequalities — both locally and globally — are therefore obvious, and they are directly linked to the economics of AI: Who will benefit from the development of AI in the world of global capitalism, and who will be the losers in this game?

Sustainability issues related to AI technology are not made visible to users of AI-based tools. To the average user, AI appears to be as free of emissions as it is free of charge, neither of which it is. The negative impacts on nature and human livelihoods, and the local and global inequalities that these technologies increase, also remain invisible. The major concerns should therefore be rapidly incorporated into educational programs — from basic education to vocational training, higher education, and continuing education — to prepare new generations, as well as adult society, to live in a world where AI is part of almost everything we do. This is easier said than done.

While technological development is very fast, institutional educational development is not. Curricula and educational programs are not revised once a month, but rather every ten years. Hence, as the understanding of the environmental, social, and economic implications of AI changes, the necessary educational development will have to take place in other ways. Teacher education, including in-service teacher training, is one of the most effective ways to bring about change in schools and educational institutions. Provided by universities, it can draw on the latest — even ongoing — research on the geographies of AI.

Geographers woke up to the importance of the topic around the same time as the release of OpenAI's generative chatbot ChatGPT. The special issue, "Where is artificial intelligence? Geographies, ethics, and practices of AI", edited by Margath Walker and Jamie Winders (2021) for *Space & Polity*, was an important opening. Another example is the conversation on 'GeoAI, counter-AI, and human geography' published in *Dialogues in Human Geography*, following a related panel discussion at the American Association of Geographers 2022 meeting, between Krzysztof Janowicz, Renée Sieber, and the journal editor Jeremy Crampton. Earlier contributions include the work of Duncan McDuie-Ra and Kalervo Gulson (2019) in the field of development geographies, and the long-standing research of Thomas Birchnell (2021), from which he summarized the idea of 'geographies of AI' in a handbook chapter. Recent research in political geography (Holden & Harsh 2024), economic geography (Rella & Campbell-Verduyn 2024), and critical geography (Walker & Winders 2024) highlights the importance of studying 'geographies of AI' in all fields of inquiry.

In this literature, the theme of education remains thinly covered. The urgent need to include the geographies of AI into environmental and sustainability education is hardly noticed. Typically, education is mentioned when considering the role of these technologies in knowledge production, learning, and teaching, or in the context of unequal educational opportunities (locally or globally) again related to the use of AI. Instead, there is less discussion of education on the topic of geographies of AI per se. In educational research, the link between AI and sustainability is acknowledged, but even there it is almost always raised in the context of the *use* of AI in educational practice: for example, how students can quickly learn about the environmental impacts of any human action through AI technology-enabled creative methods (Henriksen *et al.* 2024), or what risks can be identified if pupils rely heavily on AI-generated materials (Chang & Kidman 2023). This surely is relevant and can lead to the development of novel and efficient pedagogical methods, especially when the environmental, social, and economic impacts of AI usage are included in the exploration. But my fear is that such approaches may overemphasize the technological side at the expense of geography.

I hence propose a stronger integration of educational considerations into political, economic, cultural, social, developmental, et cetera, geographical research, rather than developing new pedagogical ideas within separate geographies of education and learning. This is not to discourage children's geographies from engaging with the topic — currently, neither *Children's Geographies* or

Children, Youth and Environment have published research on AI. By incorporating educational views into all research on geographies of AI, the latest knowledge in our various sub-fields would directly serve educational purposes. This suggestion adds to Walker and Winders' (2024, 227) notion that AI, understood as an all-encompassing societal transformation, "must be drawn into conceptual and empirical debates within all parts of our scholarly community". In their own article, educational aspects are only implicitly included, whereas in my view they should be explicitly discussed as one of the key dimensions. I echo the authors' call for critical geographers in particular to engage with AI as part of their research, regardless of the topic and their own expertise in technological developments, because leaving the geographies of AI to scholars primarily interested in the technologies risks overlooking the various geographical dimensions involved.

Critical geographers can, and must, grapple with these complex questions about AI's integration into our collective daily lives, and we must do so across our discipline. Simply put, geography's engagement with AI cannot be limited to those who "comprehend the models" or to those who "understand the questions being asked." Instead, all parts of our discipline must turn a critical eye to the complicated geographies of AI in the world around us and bring a multi-faceted framework to discussions of this disruptive technology (Walker and Winders 2024, 232).

Content of the issue

This issue of Fennia consists of six full-length articles, one review article and one essay, and three reflections texts. Included are two contributions from the Fennia Panel 2023 in Joensuu, focusing on planetary urbanisms, by Tarmo Pikner and Sanna Ala-Mantila. The panel addressed the contemporary 'planetary turn', a shift in spatial attention identified by critical scholars, NGOs, intergovernmental bodies, politicians and civil society actors worldwide. This shift moves from 'global' and 'transnational' scales to a planetary perspective, emphasizing the urgent need to see the world as a living environment of fragile ecosystems on which all species, including humans, depend. In contrast to globalization — which focuses on the global mobilities of people, goods, and ideas within a capitalist framework — and transnationalization — which emphasizes the political, cultural, and social connections between states — the planetary turn urges us to recognize the imminent tipping points of human-induced planetary degradation. To reverse the current trajectory, a radical shift towards planetary balance and justice, based on viable ecosystems and socially just environmental sustainability through urban transformation, is essential. This perspective puts an urban face on the over-consumption of resources, carbon emissions, and loss of nature that is primarily driven by urban centers and city-regional networks. The panelists explored various aspects of the 'Planetocene' from an urban perspective, addressing critical issues such as the nexus between economics and politics, planetary boundaries and ecosystem conditions in the face of nature loss and climate change, well-being and health issues for humans, wildlife and livestock, and just and ethical transformations. Comments on their views were presented by Tero Mustonen and Maija Kuivalainen, whose commentaries we hope to publish later, as well as the essay by Burcu Yiğit-Turan who acted as the third panelist. Reflections from Fennia readers are also welcome in this discussion.

The first paper in this issue, by Benedict E. Singleton, links nicely with the panel's theme. *Receipts for a healthy nature: exploring municipal officials' framings of biodiversity and human-environmental relationships in Sweden* delves into the perspectives of public officials from Gothenburg, Malmö, Stockholm, and Umeå on biodiversity protection within urban planning. By applying Pålsson's typology of human-environmental relationships, Singleton reveals a predominant paternalistic view where biodiversity is seen as a measurable indicator, a feature of place, a source of value, and something that can be engineered. The study underscores the tendency to view nature as separate from society and primarily as a technical issue, potentially obscuring alternative perspectives on human-environmental relations.

The article by Katarina Giritli Nygren and Sara Nyhlén continues discussion about Swedish environmental issues. In *SettingsObjects of affection and competing images of the Swedish North: movements for and against 'green' investments and reindustrialization* they analyze the contentious re-

industrialization of northern Sweden, particularly in Västernorrland. Using Sara Ahmed's concept of affective economies, the study reveals how emotions and traditional images of the countryside influence the debates where local communities are divided between economic and environmental concerns. The findings highlight the uneven distribution of green investments and the deep-rooted historical patterns of exploitation and marginalization. Northern Sweden is portrayed as an affective battleground where economic nationalism and localism converge, shaping the socio-political and emotional landscape of green industrialization.

Another article from the Swedish context comes from Susanne Stenbacka, titled *Disability, rurality and spatial competence: on the importance of embodied knowledge and supportive contexts*. It discusses the interaction between rural environment and disability, emphasizing place as a resource for participation and belonging. It draws from a case study conducted in a small town in Norrbotten County, Sweden. Stenbacka focuses on the embodied experiences of people with disabilities and analyzes how they use, give meaning to, and negotiate their surroundings. The paper argues that physical environment, social networks, and local welfare structures are crucial in developing spatial competence, defined as the ability to navigate social and material environments.

The fourth article in this issue of Fennia is by Anssi Huoponen who has studied the role of eco-clubs in promoting pro-environmental behavior among students in a Finnish upper secondary school. The paper *How eco-clubs foster pro-environmental behavior in a school context: a case from Finland* is based on group interviews with eco-club members and a qualitative survey of non-members. The study reveals that the members find the eco-club crucial for supporting their environmental actions and fostering a sense of community while non-members often lack knowledge about these activities and their impact. Need for better communication and engagement strategies to enhance the eco-club's impact on the entire school community are hence needed.

Continuing in the Finnish context, the next paper titled *The burden of mobility: multi-local living and its effects on infrastructure, services, and housing markets in rural areas*, co-authored by Olli Lehtonen, Olli Voutilainen, and Venla Heiskanen, explores the impact of multi-local living on rural municipalities. This increasing trend where individuals maintain residences in multiple locations affects infrastructure, services, and housing markets. Using statistical analysis and mobile phone data, the authors identify significant effects on telecommunications, road infrastructure, and service provision. While multi-local living can lead to higher property values and increased availability of commercial services, it also poses challenges, such as underdeveloped digital infrastructure and higher service costs, and raises spatial justice issues.

A third article based in research in Finland is a philosophical, methodologically oriented paper by Raine Aiava and Noora Pyry. *Dwelling with limits: the work of love in participatory research* delves into the challenges of Participatory Action Research (PAR) related to the potential silencing of the subaltern and, overall, the power dynamics between researchers and participants. The authors propose a rigorous articulation of translation, inspired by Spivak's concept of hesitant love, as a means to ethically engage with marginalized groups in PAR. By rethinking translation in terms of Heidegger's trans-position, they highlight the importance of dwelling with the foreignness of the other and being vulnerable in the research encounter. A move beyond representational knowing is suggested, to engage with the atmospheric, affectual, and processual movements that shape the research encounter.

Tarmo Pikner's essay stemming from the Fennia Panel 2023 explores the intersection of urbanism with planetary and environmental concerns. In *Resonances of planetarity and commons within evolving urbanisms*, he discusses how urbanites resonate with significant environmental matters amidst diverse disturbances, commons, and anticipated futures through vignettes related to coastal assemblages involving waste, birds, and energy in the Baltic Sea region, specifically in three Estonian venues. These vignettes illustrate the dynamic interactions between urbanization, voluminous spaces, and emergent commons, highlighting the complex urban-environmental entanglements. Pikner emphasizes the need to transform zones of ignorance into spaces of nature-culture care and commons, advocating for a planetary perspective on urbanization that values differences and contested concerns. This perspective recognizes the interdependence of life forms and the contested ways of coexisting that emerge through urbanization, pointing towards a more convivial and sustainable future.

In the review article *Reviewing research on regional development in the AI era — new there(s), new actors, and an old call 'from cluster to process*, Johanna Hautala focuses on AI-related regional development which connects nicely with the theme of this editorial. Based on a thematic content analysis of 37 research articles from various geographical contexts (including the US, Canada, Europe, China, and other key Asian countries), the study addresses where, by whom, and how AI-related regional development occurs. The results highlight a strong narrative of increasing geographical concentration and regional polarization.

In the Reflections section we include the previously mentioned reflection on planetary urbanism, and two reflections which speak to digital geographies and inclusivity in the new era of AI. Firstly, a reflection from Sanna Ala-Mantila titled *Rethinking urban sustainability: consumption-based emissions through the lens of planetary urbanization* importantly suggests that planetary urbanization involves connecting sociospatial and political-ecological transformations beyond the city, spanning wider territories and landscapes. This reflection and the other planetary urbanism pieces in this and our forthcoming issues more broadly examine urbanism through a planetary lens and show how the alleviation of human-caused climate change involves work beyond the boundaries of the city to reveal its uneven impacts in the landscape (see also Mason and Riding 2023).

Our final two pieces in this issue are reflections that return to digital approaches and inclusivity in our artificially composed epoch. In *The world makers* Kenneth Ravn explores the digital twinning of urban areas, speaking to a representational planetary urbanism. It is an engaging piece of writing, which refers to critical cartography and the work of Walter Benjamin and Jean Baudrillard to reflect upon a novel cartographic practice. Finally, we end the issue with a radical reflection that all geographers and academics more widely should pay attention to. Daniel P. Jones produces a reflection *Using easy read formats in geography* that is in an easy read format. Have a look at it and ask the question, is your research inclusive and accessible? We hope that by publishing such a radically different text in this journal it opens up the discipline, and encourages us to attend to the question Jones poses, which is, who is welcome in geography?

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