New Spatial Imaginaries for International Curriculum Projects: Creative Diagrams, Mapping Experiments, and Critical Cartography

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Abstract
This article explores the complex relational landscape of international partnerships where local and transnational education objectives are entangled. We present a methodological practice for experimenting with diagrams and maps. Our emphasis on spatial rendering of local/global relationality is intended to invite discussion about the postcolonial context of international education work and the geopolitics of transnational curriculum. We pursue a diagrammatic and archipelagic form of creative abstraction, which we present as a posthuman cartographic practice. To illustrate this practice, we focus on a specific international curriculum development project funded by the World Universities Network.

Keywords
curriculum, mapping, diagramming, creativity, Glissant, mathematical imagination, place, spatial politics

Introduction
Enduring questions regarding the notions of place and belonging, and the ways in which we are collectively earth-bound, are newly diffracted through recent climatic shifts, signalled by extreme weather events, ecological destruction, water and food insecurity, and increases in forced migration (Latour, 2017/2018; Tsing, 2015). These conditions make more evident the dependency relations and interconnectedness among all humans and nonhumans, raising anew the tensions between situated knowledge practices and large-scale mobile curriculum projects, frequently fuelled by pan-global corporate investment. The challenge for international curriculum projects under these conditions is to ensure that the interconnectedness forged at this postpandemic historical and geological moment allows for inclusive forms of being together (and apart) that resist reinstating the detached, universalist, scalable gaze of curricular entailment. What kinds of collective perspectives might allow us to engage with the “whole” of an international curriculum network under Anthropocene conditions while attending responsively to the specificity and singularity of each site, including its positioning in the history of colonization? How can we explore the complex, postcolonial interconnectedness of partial, localized, and historically situated perspectives across a collective international project or partnership?

In this article, we discuss creative diagrams and mapping experiments that were used to explore these questions in a specific international curriculum project. These diagrams demonstrate the power of spatial imaginaries to “reshape” human–earth relationality and open up alternative constellations of collectivity. The project, which is funded by the World Universities Network (WUN), spanned seven far-flung cities where eight participating universities aimed at innovating the mathematics curriculum, attending to local/global pressures, geographical, socioecological, and economic challenges. Although participating cities are positioned as part of four continents—Asia, Africa, Europe, and the Americas—we shift away from this habit of situating cities within continents, to explore how the cities form a new archipelagic network amongst themselves, in which capital and curriculum circulate and contract, exposing

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alternative relational and postcolonial landscapes. Drawing on the Caribbean scholar Édouard Glissant, our aim is to move away from framing the international network in terms of continental centres and classical maps, towards an archipelagic practice of geographical reckoning that opens up new spatial imaginaries about relationality. Thus, our aim is to use alternative cartographic devices that break with classical colonial projections, pursuing a critical and creative cartographic methodology. We experiment with alternative mathematical rules for map making, so that the mathematics itself is used as an abstract engine for producing new relations. In other words, mathematical meaning contributes to the “production of novel togetherness” (Whitehead, 1929/1978, p. 21). Our approach plays with alternate metrics, disrupting formal rules for network graphs and measurement, much like Ferreira da Silva (2017) has done with alternative numeracies. In the context of the WUN project, this led to diagramming experiments and what Deleuze (1981/2003) calls “minor” mathematical practices that allowed us to investigate different dimensions of the complex relational space of our transnational curriculum project and to reveal new ways in which the whole earth is conceived in such renderings.

We treat the diagram as a creative abstraction, a method for thinking about knotted interactions, rather than a reductive form of representation (de Freitas, 2012a, 2012b). This focus on creative abstraction is crucial when mobilizing the diagram: “The essential thing about the diagram is that it is made in order for something to emerge from it, and if nothing emerges from it, it fails” (Deleuze, 1981/2003, p. 159). Rather than representing relations, the diagram becomes a creative abstraction when it makes new realities possible by unmaking previously determined claims. We take inspiration from the philosopher of mathematics Gilles Châtelet (2000) who shows how inventive mathematical diagramming has been historically linked with new spatial imaginaries in other fields. He suggests that diagrams be studied for their gestural and generative power, as they carve up space and rearrange material relationships (de Freitas & Sinclair, 2012). For Châtelet, the diagram is a kind of analogy machine, remixing matter and concept, and actualizing the indeterminate potentiality of worbling activity.

In this article, we are focused on how diagramming experiments might help us rethink the complex relationality of an international curriculum development project. We diagram the international project, attending to constraining geohistorical structures of postcolonialism that persist in many international curriculum projects. These diagrams are network maps, exposing our assumptions about relationality, allowing project partners to interrogate the extent to which their models of cooperation and networking continue to be caught up in rigid rules about local-global, scale, interactivity, and so on. In a similar vein, Braidotti (2011) suggests that cartographic methods can be used to create “a politically informed map of one’s historical and social locations” (p. 385) that can “enable the analysis of situated formations of power” and thus create potential locations for resistance. Critical cartographic methods, in this instance, should not be reductive representations of the real, but operate as provisional, responsive, and mobile devices, attending to nonlinear, dynamic relationality. In other words, the cartographer seeks “to map out spaces where what-was meets what-might-yet-be” (Kuntz, 2019, p. 85) in more-than-human milieus. This “what-might-yet-be” has ontological implications inasmuch as it aims towards social and ecological change.

This article contributes much-needed specificity to this kind of vision, by directly engaging with the metrical and structural aspects of maps. Neither Braidotti nor Kuntz offers any actual diagramming or mapping experiments. Instead, they speak metaphorically about a new “cartographic method” without demonstrating how to play with specific spatial renderings, unconventional mapping practices, alternative metrics, and graphical visualizations. We aim to address that “silence,” and perhaps also to “follow through” on these claims, by showing how diagrammatic experiments in creative abstraction might be used methodologically. Only through actually experimenting with diagrams and spatial imaginaries, can we raise awareness about part-whole relationality, local invariance, global animacy, and distributed proximities, all of which constrains/enables a collaborative curriculum network. In the next sections, we discuss the WUN project and the archipelagic thinking of Glissant, before revisiting standard mapping conventions and alternative diagram experiments, considered, in part, through the lens of postcolonial and posthumanist practices.

Towards New Geographic Relationalities

The WUN project involves a network of researchers and their Universities, in different countries (Canada, Hong Kong, Mexico, South Africa, the United Kingdom, and the United States), pursuing different curriculum development and research initiatives that all fall under the umbrella of Innovating the Mathematics Curriculum in Times of Change: Towards Local and Global Relevance. Our project operates within the landscape of growing calls for innovation in the mathematics curriculum in the face of a rapidly changing world (Skovsmose, 2019), particularly in relation to the current climate crisis (Boylan & Coles, 2017; Yaro et al., 2020) and to ongoing decolonizing efforts (Nicol et al., 2020). Changes to migration patterns, global pandemics, and planetary climate change are felt locally and differentially across economic, biological, and affective scales. These changes are inflected by colonial encounters through the institutions implicated in addressing them, the methods
used to manage them, and the values underlying who or what needs improving and when. The discipline of mathematics itself is also inflected by colonial encounters (Bishop, 1990; Joseph, 1987), not only through the sociomaterial conditions of its practice across histories but also in the particular ways that the teaching of mathematics forced these practices into a verbal and abstract lingua franca, thereby performing erasures of meaning and context (see de Freitas & Sinclair, 2020). The stated agenda of the project is to make the curriculum relevant to learners, where relevance entails connecting the curriculum to particularities of place, context, and ecology. Relevance, however, is a moving and mutating concept, itself changing in relation to place, connectivity, proximity, verticality, and other spatial/relational concepts.

In considering these reimaginings of space and relationality, we have found resonance in the work of the Caribbean thinker and poet Édouard Glissant (1928–2011), who asks how we might “live the totality of the world as a temporal layering of the linked histories of peoples” (Keeling, 2019, p. 198). In his own spatial experiments, Glissant suggests that we seek a poetics of networked relation, a kind of “tout-monde” that is not a closed whole, but an open archipelago of moving parts. Glissant (1991/1997) offers a radically different approach to thinking about place and connectivity, developing a distinct “archipelagic” philosophy of relation that has been described as “simultaneously Deleuzian and Caribbean” (Drabinski, 2019, p. 99, emphasis in original). Glissant diffracts the world through the Caribbean Sea, pursing a generative aesthetics of the earth. It seems to us that this approach is promising as we try to imagine new political ecologies and corresponding forms of spatial practice, mobility, and sense of place. Glissant (1991/1997) avoids stories of ground and origin (like the tree or the top-down hierarchy) that affirm filiation and lineage, and instead develops a means of “com-prehending” a multiplicity, a new way of thinking with parts and wholes, preferring the neologism “donner avec” or “give-onto” rather than “grasp” when making sense of relationality.

Connected to the image of an open archipelago of moving parts is his conviction that “The whole world is creolizing itself” (Keeling, 2019, p. 198). Working with and against the classicisms and subjectivism of French education on the island of Martinique, Glissant (1991/1997) uses the rich lyrical creativity of the Creole language as a line of imaginative flight—not the speakers of the language, with the right accent and proper vocabulary, but the language’s own orality and opacity. Creolization, however, is not only a politics of refusal, not only a form of resistance to the colonial plantation regime, but also involves an aesthetics of the earth—in his words, creolization performs a “baroque derangement” having to “renew itself on the basis of a series of forgettings” (p. 69), creatively remapping historical relations across human and nonhuman boundaries and rerouting the classical aesthetics. For Glissant, creolization is more than linguistic and cultural expression because it opens onto a political ecological perspective, where we are engaged with an inherited earth and “écho-monde,” and must reckon with “the integrating violence of contaminations” (p. 91). This is no simple spatial imaginary, but a complex rhizomatic model with a corresponding ethics of participation. Glissant remaps the earth from the situated postcolonial space of the Caribbean Sea, moving with an infinite “chaos-monde” that demands that we stop “englobing” in classical spherical renderings, and imagines instead a rhizomatic “tout-monde” (or open totality). Glissant invites alternative ways of thinking about relationality and territory, focusing as he does on the opacity of the Caribbean black beach, a middle territory of shifting tides, opening onto the abyssal Atlantic, and the errant relay of speculative thought. Glissant helps us rethink project participation in terms of an errant entangled network of postcolonial paths and relays.

We are struck by the force and novelty of Glissant’s spatial imaginaries and how they might help us both interrogate and reimagine an international curriculum project. In particular, we ask, “What are the rhizomatic spatial imaginaries that might be engendered, to assist in reconfiguring this new relationality?” “How might ground-and-origin stories of curriculum—pervasive in most countries—be replaced by the lateral multiplicity of archipelagic moving flows?” and “How might our curriculum project remain sensitive to the ‘integrating violence of contamination’ that Glissant also emphasizes, precisely through such reimagining of spatial relationships?” We suspect that existing geographical imaginaries make such questions difficult to formulate, precisely because we are wedded to conventional forms of representing the relational landscape of an international network. Glissant’s ideas have recently sparked diverse work across the social sciences, often as a form of correction to isolationist tendencies in “island studies” which have framed “the local” in simplistic ways (Stephens & Martinez-San Miguel, 2020). Following Glissant, and drawing also on Deleuze and Latour, we consider next the complex diagrammatic nature of geographical mapping.

Spatial Imaginaries: Mapping and Territory

Maps are ways of expressing and inventing local/global relations and have functioned this way for centuries. Latour (1988) recounts how mapping practices dangerously control what is taken to be in/visible, serving capitalist, imperalist, and commercial interests. He emphasizes the destructive power of the mathematical gaze from elsewhere, drawing static maps that fix and indeed misrecognize the fluid relationality of the earth: “Scientists start seeing something once they stop looking at nature and look exclusively
and obsessively at prints and flat inscriptions” (Latour, 1988). The flatness of the map is also crucial in invoking and maintaining mastery; one can dominate a flat surface where there are no hidden convolutions or shadows. Whenever one needs to master a subject, says Latour, look for the flat surfaces that enable that mastery—a map, a list, a file, and a census. Mapping is a thoroughly political and material practice.

For example, this 15th-century rendering of Ptolemy’s world map (Figure 1) is constructed from his atlas Geography (c. 150) and marks the significant places and spatial relationships known to him. Working with Roman-era survey data and a form of projection for latitude and longitude, Ptolemy would have also relied on the mathematician Eratosthenes’s earlier cartography and theoretical measure of the earth’s circumference. Our earliest copy of this map comes from the 12th century and we don’t know if the original much older Geography actually contained it—he may have instead listed data, diagrams, and formal rules for projection. In this article, we treat such maps as part of cross-cultural investments in picturing the cosmos, that is, in “cosmigraphics” (Benson, 2014).

Maps like these convey particular perspectives about the metric relations between human, nonhuman, and earth. Mapping is a way of situating, projecting, and distributing proximity and operates as a technology of existence. Consider the contour map of Table Mountain (Figure 2), a
geological feature by which the partner city of Cape Town, South Africa, has come to be recognized internationally. During colonial occupation, indigenous people were forced from the lush slopes of Table Mountain. Colonial processes of dispossession were cemented during apartheid when citizens not legally classified as “white” were forcefully removed from these slopes (where market gardening was productively conducted) to the sprawling, sandy “Cape Flats.” These marks of difference endure in a time of post-apartheid spatial planning, captured in the particular graphical intersections of the contour lines and partitioning of property lines (see Motala, 2020). In this postcolonial context, the contours mark not only geological and ecological differentiated elevations but also enduring material and symbolic racial, socioeconomic, and linguistic hierarchies.

Once made, maps seem to show what is actually there, in the world. The ultra-visible Table Mountain is decoded discretely into its changing elevations. But of course, as Latour asserts above, and Glissant eloquently evokes, space is concretely inexhaustible, constantly open to new relays and circuitry. For example, at another project site, near Mexico City, the mortality map (Figure 3) tracks the flow of the Atoyac River, showing how its waters move the pollution produced by national and international factories discarding dye and heavy metals through its tributaries (Solares-Rojas et al., 2020). The river has not supported fish for over 20 years and there are emerging health effects on communities living close by (Arellano-Aguilar et al., 2015). Indeed, the map shows starkly the way in which mortality hotspots—strewn like archipelagos across the Atoyac basin—transform the continuous current of water into discrete outbreaks of disease. The poison-producing factories circulate death across the entire region, through the giving-on of the water, the villages, and tiny tributaries that protect as well as maroon.

New mapping practices are increasingly relying on crowdsourcing technology that produces just-in-time global positioning system (GPS) information. For instance, in Figure 4, a mapping app, developed under the category of “travel,” updates the live location of partner city Hong Kong, where clashes between police and activists were frequently occurring, during the WUN project. With the mapping app, individuals who move quickly, sometimes producing crowds, can know where tear gas or water cannons have been deployed and where police are advancing. Although we show a snapshot of the map here (Figure 4A), it is a dynamically changing one, populated by emojis that indicate the presence of tear gas (white speech-bubble), police (a dog), and protesters (a worker in a hard hat). Located on people’s smartphones, these maps can be zoomed in or out, showing local dangers but also the flow of movement that includes that of the person holding the...
Figure 4. (A) A live Hong Kong map during the protests on August 31, 2019. (B) Another map produced during a December 2020 protest.

Source. https://qz.com/1700205/real-time-mapswarn-hong-kong-protesters-of-police/
smartphone. Given the difficulty of achieving accurate enough information at real-time speed, other mapping practices have also emerged, that track change over relatively short durations of time (15–20 min), but with high accuracy, showing densities and speeds of crowds (Figure 4B). These virtual maps are created through the labor of on-the-ground immersive “runners” who observe, annotate, and transmit information to the so-called “integrators” sitting in the control room. With the rapid deterioration of freedom of speech in Hong Kong, these maps involve fluid and dynamic responding to distributed, human-annotating/computer-geolocating representations whose simultaneous updating can also produce unexpected configurations, errors, and dangers, as when the police begin to use the maps to control dissent.

Fluidity and just-in-time human/geolocational feedback are precisely what makes the maps used by the Marshall Islanders over the last centuries so powerful as navigational devices. Instead of providing an external, flattened map of the islands and atolls, the mattang stick chart map was used while at sea \textit{in the water} as a kind of land/sea interface, responding to the swells of the ocean, the location, and the body of the navigator (Ascher, 1988). The tied arrangement of sticks (see Figure 5) seems highly abstract, lacking signs that tag it to particular places; however, these mattangs are powerful diagrams for navigating specific oceanic relational movements in the south pacific.

We believe that there is something about the Mattang that answers to the inventiveness that Braidotti (2011) seeks, as discussed in our introduction, perhaps by virtue of its abstract diagrammatic quality, and its emphasis on the intensive dynamics of tides and wind between the apparent fixed locations of land masses. All of these examples of maps reveal novel spatializing practices and have been presented here to help convey the political-material nature of maps. The different maps we have surveyed are creative engagements in earth–human relations, embodying different possibilities and potentialities for suppression and resistance. In the next section, we bring Deleuze’s (1981/2003) work on the diagram and the map together, emphasizing his focus on the innovative and creative potential of diagramming as a technique for the “open conjugation of intensities” (Manning, 2009, p. 124).

### Diagramming Relationality

Standard spatial visualizations of part-whole relationality reveal assumptions about hierarchical power distribution. The dominant conceptualization of local and global scales seems to cast the global as either rigid oppressive top-down force (Figure 6A) or immaterial passive result that is simply the sum of the parts (of the local), where those parts may intersect or not (Figure 6B). The former might evoke a vertical causality, and the latter that of covering and containment. In the systems theoretic approaches of Maturana and Varela (1980), patterns at the level of the whole system are said to emerge from local actions and the vertical causality is said to move in both directions. For example, the bottom-up nature of phenomena and its emergent unity (i.e., how the flight of each goose contributes to the V shape of the flight pattern of the geese) is combined with the top-bottom causal effects (how the V formation constrains the flight of individual birds; Juarrero, 2002). And yet such reversing of push and pull does not stray or alter the fundamental structure of the tree diagram or the Venn diagrams in Figure 6.

In the context of an international curriculum network, the shape or content of a global curriculum would emerge from the amalgamation of local curriculum innovation efforts, tending to collate shared practices and/or shared constraints, to the neglect often of local peculiarities. Such an approach has its benefits—but it also has limitations, especially as it continues to engender \textit{subtractive} abstractions that transcend the specificity of place, and continues to maintain a \textit{vertical} structure. In other words, even when models of international curriculum are generated from bottom-up sharing processes, these processes will remain \textit{reductive} through their subtractive actions, resulting in dislocated “curriculum standards,” despite the intention to avoid these.

Latour (2009) underscores the important link between spatial conceptualization and assumptions about the world more broadly, when he writes, “Tell me what your position on space is, and I’ll tell you who you are” (np). He contrasts two conceptualizations of space, where the first is “the \textit{inside in which} reside objects and subjects,” and in the other is “one of the many connections made by objects and subjects” (Latour, 2009, np, emphasis in the original). In the
former, which aligns with Figure 6, space is structured as a container, containing other smaller containers, with no agency or mobility, whereas in the latter conception, space is engendered through mobilities, agencies, intensities. In the former, space is abstract and passive; in the latter, space is intensive and concretely inexhaustible. In the former, the local is contained in the global. In the latter, the “global is a form of circulation inside” (np) the local.

If the global is a “form of circulation inside”—rather than a container—we must rethink the flow between local and global and realize that the “whole,” or as Glissant states, the “totality,” must be plugged into the web of particulars. The goal is to disrupt the promise of or desire for transparency in the form of completeness or coherence. This can be found, for example, in the rhizomatic networks of Deleuze and Guattari (1980/1987), which are nonhierarchical and composed of many entry points and mobile loops (you can move a part and stick it somewhere else). Similarly, Sloterdijk (2004/2016) draws on foam imagery that, unlike two-dimensional networks of nodes and lines, expresses multi-and self-similar cellular agglomerations.

These alternative diagrams envision distinctive potential for new forms of relationality, opening up alternative ways to stitch local knowledges and practices together. We caution that experiments in diagramming part-whole relationality are never safe or innocent. But precisely for this reason we believe that experimentation with creative abstraction is needed, aware that there is no fending off the all-consuming forces of oppressive globalisms, but that there are significant differences between maps and their material implications. We don’t want to invest in a mathematical lingua franca that translates all diverse practices into a reductive abstraction, for doing so would amount to endorsing the transcendent universalisms that inevitably inflict an oppressive ordering onto peoples and cultures. We can work towards avoiding these traps if we turn to diagramming experiments that put mathematics into the messy metamorphic zone of speculation.

Deleuze (1986) (citing Foucault) suggests that the diagram is an “abstract machine” which “makes no distinction between content and expression” (p. 34). In other words, diagrams are said to “function as pragmatic exercises of finding out how something works . . . Such diagrams would be about realizing abstractions rather than identifying the referent that is being stood-in-for” (Freitas, 2012a, p. 594). The power of the diagram is developed further in Deleuze and Guattari’s (1991/1994) geophilosophy, where they pursue maps of an “intensive spatiun” that break with res extense (the extended thing) that is typically presumed in most map making and methodologies of the earth. In other words, they ask us to experiment with the ways in which intensity animates the apparent fixity of any map that claims to capture distance, proximity, connectedness, and so on. This intensity refers to flows of difference and variability, rather than to fixing “in place” a particular configuration.

The term intensity is key for realizing the earth as an ontogenerative ecology rather than a static passive sphere or globe; intensive forces are precisely what resist the rigidifying tendencies of map making and allow for a rethinking of spatial relationality. Indeed, intensity might be the key concept for thinking the whole without always thinking the universal obliteration of the local. Intensity is what makes the abstract line in a diagram quiver with indeterminacy and resistance; it thereby opens onto the poetic, speculative, and creative capacities of the earth and the human (in excess of the line). Intensity is never “contained” in any one locale or place, always inflecting and twisting the relational landscape. As Roussell (2021) explains, the intensive quality of Deleuze’s “cartography-art” makes “cartography an art of transitions and forgettings rather than one of historical memorializations, biographic remembrances, or archeological excavations” (p. 4). For Deleuze, the map is not simply an impoverished representation of the real because “extensive trajectories of movement are inseparable from intensive processes of becoming-other, and the purpose of a
cartography-art is to render the ‘mutual presence’ of these trajectories and becomings through techniques of making visible, audible, sensible, or otherwise palpable” (Rousell, 2021, p. 5). And part of what is brought into presence is the affective relations and resonances in a situation (Barry, 2017, p. 331).

For Glissant (1991/1997), however, intensive relationality sustains the flow of onto-epistemological resistance to rendering the Other transparent and legible. This refusal to submit to representation is part of Glissant’s “poetics of opacity” that expresses a nomadic and differential view of earthly belonging, leading to his embrace of a relational network or “open whole” associated with the Caribbean archipelago. Thus, he seeks a sense of a “totalité,” but also reckons with fragmented forms of belonging together and the history of postcolonial violence (de Freitas et al., 2022). Inspired by Glissant and Deleuze, we aim here to explore novel forms of relationality and experiment with diagramming practices that might engage with the intensive spatiurn, in all its opacity.

**Project Diagrams**

In this section, we present some of our diagramming experiments. We first generated diagrams under the constraint that they be constructed with lines and nodes, realizing that enabling constraints are necessary in creative work. Everyone was then asked to draw on diverse mathematical concepts that might break with standard conventions and help reimagine local and translocal. We encouraged playful and disobedient diagramming techniques. In each case, we used the diagrams to elicit discussion during team meetings and to raise awareness about unexamined forces that were structuring the international network. These discussions occurred during monthly meetings on Zoom, where we shared and discussed project goals across our diversely situated locales (Bristol, Cape Town, Hong Kong, Manchester, Mexico City, Vancouver, and Edmonton). The diagrams are not offered as answers or solutions, but used as devices for exploring new spatial imaginaries and the power of creative abstraction to engender new insights.

These diagrams are of course personal expressions composed by network members, reflecting situated perspectives, engendered from distinct geographical locations. These are creative abstractions, not intended as exhaustive representations, but as partial and fragmented maps of the archipelagic network. The challenge was to think with the “trans-positions” of our current network by mobilizing alternative metrics and graphics, in such a way that diverse forms of relationality became visible. Like all maps, these are ground in both the particular and the general, exploring spatial imaginaries at the scale of the network and the earthbound. These maps, however, contest the conventions of center and periphery that dominate Eurocentric mapping traditions, where the “continent” is the center and the scattered islands are the periphery. Given the persistence of such traditions, and the postcolonial reality they document, we have deployed the speculative capacity of mathematics itself to furnish us with new spatial imaginaries and new modes of documenting our relationality. We remind the reader, however, that mathematics does not transcend place and cultural tradition, but rather that mathematics entails habits of creative abstraction, which emerge from within “places” everywhere (de Freitas & Sinclair, 2020). This approach is meant to bring mathematics into the fold of critical geography (i.e., Soja, 1996), as not simply that which entrenches the status quo, but as a methodological tool for breaking up rigid dogma and thinking otherwise (Badiou, 2006). By mobilizing key ideas from knot theory, topology, and projective geometry, we have tapped the force of mathematics to creatively play with form, structure, and map.

The first two diagrams attend to north–south distributions of power and knowledge. They thus enable us, as a network, to engage directly with tensions associated with a mathematics curriculum that is assumed to be universally relevant. The diagram shown in Figure 7 uses the longitude–latitude coordinates of all seven cities, with many clustering around latitude 50° N. Notably, Edmonton and Hong Kong are located somewhat symmetrically around the meridian, with approximate longitude 114° W and 114° E. The “equator” and “prime meridian” are represented as a heavy cross carving up the space into quadrants, evoking grids and separation, and Euro-Christian colonial conquests. The colonial history of this kind of geometry is emphasized in the marking of north–south quadrants and the making of the subaltern—literally, the rank below the “captain” of the north. Lines are drawn to mark the “trade triangles”—a term used to describe the trading paths of

**Figure 7.** The trade triangle map.
capital and commodity movement from the United Kingdom to Africa to the Caribbean. These trade triangles ensured there was never an empty boat traversing the black Atlantic trade routes, as slaves, cotton, and mortar were carried from node to node along the paths of the trade triangle. By showing how our network was situated in the afterlife of slavery and colonial trade, the map made evident how most of the participating cities clustered around latitude 50° N, underscoring the socioeconomic status of participating institutions and the correlation of SES with patterns of geographic settlement.

The lines that leave the flat page on either edge in Figure 8 evoke another possible polygon, another trade route, where east and west reengage in the opaque space behind what is made visible here, connecting Hong Kong to Vancouver. This link gestures toward an open whole, puncturing the insular triangle, fracturing the singular ocean back into its making parts. It also weaves in current academic/supervisory filiations, pointing as it does to the lineage of scholarship between participants in Hong Kong and Vancouver. We must ask, "How does our network handle the multiple filiations, including colonial and academic, at play?" and "How can we move from filiation to alliances, as Glissant suggests?" One possibility can be found in the way the map disrupts the convention of encoding east–west as left–right, as Hong Kong is on the far right and Vancouver–Edmonton on the far left. Such a simple gesture raises spatial awareness.

In the next diagram shown in Figure 8, projective geometry was used to create an inversion puzzle, producing a geometric inversion between line and circle. Inversion is a kind of transformation that has the effect of turning the plane inside out about a given circle—thereby once again, but differently, disrupting north–south spatial imaginaries. The idea was invented by Jacob Steiner (1796–1863) and led to new branches of mathematics. To invert a number in arithmetic usually means to take its reciprocal. The process of inversion can be used in geometry to transform a difficult problem into something more tractable. To make an inversion into an involution, one maps the center of the circle to an imagined point at infinity, thereby opening up the finite rendering to an infinite outside. Once chosen, the inversion of straight things (segments joining two nodes, rays and lines) will almost always be curved things (like an arc or a circle) that pass through the center of the circle of inversion. In other words, points that are infinitely far away curl into the finite middle. There is a measured precision in this inversion diagram, in the stipulation regarding the ratio and location of line and circle. Geometric inversion correlates any point (Q) inside a circle (center O, radius r) with one outside the circle (P), such that OP / r = r / OQ. The closer the point Q is to the center, the further away the point P is projected, until the circle’s center correlates with a point at infinity. This exercise of inversion in mapping upturned the usual expectation of the relationship between node and link in a network—where the link expresses Glissant’s idea of Relation, that which precedes the nodes, rather than arising from them. This inversion functions as a creative abstraction—a geometry of duality—that forces us to posit a new perspective from which Edmonton and Cape Town, for example, might share in unexpected proximities. The circle of inversion can be chosen arbitrarily, thus performing the crucial act of contingency, instantiating that point of view, the force, that will produce the relation.

The inversion map also raises questions about relationships between center and periphery and the ways in which an infinity (imagined but no less powerful) occupies our sense of place. The circles/nodes of Vancouver and Manchester intersect, capturing the joint writing habits of the co-authors de Freitas and Sinclair. As lines become circles under the inversion transformation, the bidirectional flows of goods and slaves that made the trade triangle now devolve into vortexes, dethroned of their power to circulate in the same way. After an inversion, everything that was inside the circle will move out and vice versa. Objects that might have been far apart on the outside will grow closer on the inside, and vice versa. Choosing a circle of inversion that includes Europe, for example, would perform a scattering of former alliances and might redistribute other proximities. How do we take care of the new lines—new edges—we’ve made? How do we make sure that new trade routes of power and knowledge are nonextractive and reciprocal? Specifically, how might
curriculum developed in Bristol be handled, as it moves along the edges? How do we make sure that it is given its ontological dignity and allowed its ontogenesis with other researchers, in other locations? These two diagrams use graphical elements (grid/quadrature, polygonal shapes, inversion) that are mathematical in their rendering and conceptualization. But they also generate new ways of thinking, *speculating about new relations*, new future movements. Any measuring practice is somewhat paradoxically imbricated with matter, and thus ultimately both objective and subjective, abstract and concrete, collective and singular, global and local. We see this map as a “creolisation” process that breaks with colonial mathematics and instead folds mathematics into a critical geography, as a detector of violence and contamination. In refusing the typical tame and clean measures of Euclidean geometry, this map discharges messy mathematical relationships that cleave to the world without their Western units.

Diagrams in Figures 9 and 10 draw attention to the earth’s animacy and agency. The first (Figure 9) sets the seven sites as though they formed a fish in its watery milieu, a creature that swims the diffractive sea of Glissant. In this diagram, Bristol is the all-consuming mouth and Cape Town the eye. The spiral around Hong Kong stresses the current crisis around its political status and independence, as the “rent” on its land expires, shifting the island’s “belonging” from the United Kingdom to China. The network lines cross over/under to emphasize movement or blockage, and the fish opens onto the sea with these overlays, so that the creature passes through that which passes through it. The sea is within the fish—as though animacy and flow were one and the same.

The diagram in Figure 10, made with a 3D (three-dimensional) pen, expresses the different project nodes as 3D lines, color-coded with six different looped strings of wax, and creates an alternative way of characterizing the intensive flow of ideas across the network. This map puts the sites of the project into motion along the line, so that all is entanglement. Place is stretched across the spatiotemporal network, as pure entanglement. Turning nodes, as things, into loops, as operators, is the quintessential move of modern abstract algebra, which focusses not on the properties of objects but on their behaviors. With Glissant, these loops express the archipelagic, temporal layering of linked histories of project participants. Instead of only relations of proximity and power, we produce intersections, overlappings, knotting, and evoke temporal duration. The 3D pen allows for a map—like the Marshall Islanders’ Mattang—that is haptic and volumetric and is used here to emphasize some of the collaborative histories among the network, in which curricular ideas have been shared. The topological orientation of this diagram does away with Euclidean concerns with imperial distance and fixed location. In the case of the 3D pen, the droopy wax hardens over time in-formation with gravity, susceptible to the local conditions of moisture, as they congeal.

The petal diagram (Figure 11) points to alternative ways of working with grids and entails a legend and annotation. This is a process map and documents the unfolding relationship between earth, measure, and the imagination, the latter signaled through the emergence of an “escape petal” and the unstable asymmetric crystal formations in the lower corners. This circular grid enables a process diagram of conceptual de/re/composition, whereby earth (coded by circles) begins in an intensive layering of bubbles in the upper left portion of the diagram, then breaks apart into petals and later into an unstable crystal formation of diamonds. The diamonds are both the mark of a brutal violent history of colonial mining, while also the birth of a fragile form, a creative abstraction. The legend indicates that the diamonds are code for “hypothesis” which is itself a powerful mode of speculative thought,
particularly in mathematics. The diagram shows how time’s arrow is split, announcing the formal force of indeterminacy and vagueness, as hypotheses are materially engendered. The static, flat, and snapshot-like maps of the Earth that we usually see, which seek to capture identity and location, are turned into ontogenetic operations, tracking the dynamics of conceptual gains and losses: Petals are shown to metamorphosize, hybridize, and crystallize, renewing themselves as they seed and scatter.

The dotted lines on the paper invite the eye to move along actual arcs, but also to see potential ones that have not yet been traced—gesturing again to a tout-monde of open navigation. The petal diagram also shows another kind of part–whole relationship, among circle, petal, diamond, enabled by the specificity of the alternative grid structure, in a Glissantian “baroque derangement.” Given the persistence of such traditions, and the postcolonial reality they document, this map proffers a new spatial imaginary and a new mode of documenting our relationality. In petal logic, there is no origin, no Cartesian coordinate grid.

The diagram in Figure 12 tracks project participation as kinetic energy, so that the creative capacity and production of the project is captured in a brewing storm cloud over time. This map is based on meteorological methods for studying atmospheric effects like the emergence of thunderhead clouds. The project sites have been positioned on a plane, while the third vertical axis marks the evolving collective effort of the collaboration, as it gathers steam from different sites at different times over the life of the project. This map tracks the intensive flow of energy between participants, in the process of curricular innovation. Atmospheric formations like this are not simple aggregates of parts and require new mapping methods to gather the newly distributed proximities. This last diagram points to the complexity of collective efforts, and the modes by which ideas, engendered in one location, can seed clouds with particular powers under shifting conditions. This diagram raises questions about how to modulate these atmospheric processes and perhaps begin to understand our project aims under new climate regimes.

Closing Comments

Latour (2015/2017), Haraway (2016), and Tsing (2015) remind us that the earth is fully situated and we need to grapple with its finitude—indeed, echoing Whitehead (1929/1978), Latour suggests that the earth “inflicts” on humans their return from the infinite realm of ideals, back into the folds of the material finite world. He states repeatedly, “The earthbound have to explore the question of their limits” (pp. 290–291). For Latour, “the infinite realm of ideals” leads all too easily to abstractions that erase the finite particular and impose the general model. Despite these caveats, we think it essential to affirm the creative power of abstract forms as alchemic expressions that are powerfully earthbound. Rather than blame abstraction for its detachment from the real, we show how abstract forms can be
a source for thinking creatively about earthly spatial dynamics. In particular, we show how mathematics is quite useful in post-human projects, for those intent on “imagining otherwise,” furnishing the “wherewithal” to create hypothetical spaces that have never been experienced—spaces with 17 fractional dimensions; spaces of no continuity, of infinite stretchability; spaces where inside is outside or where there is no other side. In that spirit, we treat the diagrams included in this article as playful attempts to refold or relay Glissant’s “totality” through the mathematical possibilities of a transcurricular project focused on mathematics. These diagrams were shared and discussed during displaced zoom meetings, allowing the network partners to engage directly with the spatial politics of our collaboration. They kept us from settling into easy positions about curriculum and collective efforts.

These mapping experiments were also inspired by Mbembe’s (2017) insistence that more attention needs to be paid to how past and present colonial encounters change us all, no matter where we are. He also argues that sustained reflection on transnational encounters offers the potential to “rehabilitate singularity and difference” (Mbembe, 2017, p. 158). Such injunctions can help frame the work of international curriculum projects, especially projects that are focused on mathematics, which harbours within it so much potential for producing and imposing harmful universals. Our focus on spatial imaginaries as a fertile conceptual ground for rethinking our own curriculum project aims not to produce new map-making rules, but to encourage cartographic gestures that animate and explore the difference/tiang earth. Indeed, we are not looking for best practices in curriculum design or to export course outlines. Furthermore, we are committed to exploring the way in which mathematics itself is more than a global discipline practiced in local styles (Cartier, 2012), being also a powerful force for creative abstraction, enhancing our capacity to imagine new forms of inclusive rationality. Recognizing that curriculum involves an alchemical process that transforms knowledge for the purpose of instruction, as Popkewitz (2004) argues, and that contemporary mathematics curricula frame mathematics as a “stable structure of possibility and productivity of divesting ourselves of the simplistic relations of abstract/concrete, local/global, and top/down that too often guide collaborative educational projects, whether they be intercontinental like ours, or cross-national. While the “performances of livability” (Tsing, 2015, pp. 157–158) in precarity may be different in different contexts, the ultimate horizon, for Mbembe (2017), is the same, that is, “how to belong fully in the world” (p. 176). This “world” is one of the divergent, layered, and conjoined projects (Tsing, 2015, p. 22) that involve all humans and also nonhumans, including the creative abstractions of fungi. We argue that the geomathematical commitment of the mapping methodology we explored in this article can be productive in thinking experimentally about such conjoined projects.

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**Notes**

1. See https://wun.ac.uk/wun/research/view/innovating-the-mathematics-curriculum/
2. The app is later banned by China (for encouraging illegal activities): https://www.bbc.com/news/technology-49919459

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