



In Conversation with Steven Khan: Sensible and Sense-able Qualitative Literacies for Multi-species Flourishing

Steven Khan and Marc Higgins

As our planet undergoes the equivalent of a violent and rapid (in geological terms) phase-state transition—multiple extinctions looming—brought on by the activities of a single species of thinking and way of Being—Man—what are our responsibilities to ... other non-human nations? (Khan, 2020, p. 239)

Marc Higgins: Thank you for agreeing to take part in this interview: I continue to be grateful for your scholarship, practice, collegiality, and friendship. As I have mentioned to you, part of the intent of this collection is to bring together folks to speak from either within science education, to science education, or from adjacent but highly relevant locations around

S. Khan (✉)
Brock University, St. Catharines, ON, Canada
e-mail: skhan6@brocku.ca

M. Higgins
University of Alberta, Edmonton, AB, Canada
e-mail: marcl@ualberta.ca

the question of what it means to teach in response to, within, and to trouble the Anthropocene.

Within your recent work on multi-species flourishing (e.g., Khan, 2020; Khan & Bowen, 2022), there is a felt sense that perhaps the naming of the Anthropocene serves to mask particular power dynamics that are front and center in your work. Could you speak more about the ways in which the Anthropocene at once poses an important challenge for STEM education and simultaneously needs to be challenged (e.g., attended to otherwise as Plantationocene)? Specifically, what does it mean to do this work in the space of mathematics education?

Steven Khan: I won't try to define the Anthropocene¹ but acknowledge that what falls under its umbrella, or parts of it, definitely falls within the gambit of STEM education or in terms of what it imagines it's about. Also, there are things that are outside of both of those as well. When I think about the Anthropocene, I want to start with the fact that it is a concept that comes out of a particular disciplinary discourse and has moved into public consciousness in a fairly rapid and meaningful way for particular purposes. Similarly, we have other concepts from other disciplines doing that, as well, so things like critical race theory or intersectionality or the one that was I having a discussion about this morning: the concept of proofreading is not what most people think it is from within the sort of formal editing perspective versus the common place

¹Yusoff's (2018) eviscerating critique of White Geology's ongoing complicity and willful ignorance or intentional blindness toward communities who continue to live within its racist-colonial-capitalist-ecocidal wake (see Fig. 21.2) resonates. She argues:

If the Anthropocene proclaims a sudden concern with the exposures of environmental harm to white liberal communities, it does so in the wake of histories in which these harms have been *knowingly* exported to black and brown communities under the rubric of civilization, progress, modernization and capitalism. The Anthropocene might seem to offer a dystopic future that laments the end of the world, but imperialism and ongoing (settler) colonialisms have been ending worlds for as long as they have been in existence. The Anthropocene as a politically infused geology and scientific/popular discourse is just now noticing the extinction it has chosen to continually overlook in the making of its modernity and freedom. (Yusoff, 2018, p. xiii, italics added for emphasis)

We too say this is not new; it is known, has been known, and is only finally of concern to White Imaginaries of exceptionality or difference due to the existential risk it poses to a particular way of being human that has masqueraded as the only way of Being Human—Man (Wynter, 2003).

understanding. Within the geological sciences, the term Anthropocene has a very specific and limited but important purpose for *that* discourse community. It is a tool for thinking and research and complicated conversation.

Our question is: what happens when we take it outside of that? I do agree that it functions outside of that as a mask. It's a discursive signal to see that we're doing something or thinking about something that's related to what the geo-scientists are thinking about. It is attention grabbing, which is important in today's limited attention economy and fragmented attention landscapes. It does that without really getting at the ways that particular systems are organized, and the logics that underpin those systems and how they came to be, so that historical dimension of our many planetary precarities that are more directly related to our day to day work in education than the geologic. It is simultaneously historical in the geological sense and ahistorical in the social sense. I feel as well that the term diffuses and generalizes responsibility for these global effects so that, ultimately, no one is accountable: not locally or not globally. That is where part of the issue is.

Thinking about the Anthropocene and all the differing variants of STEM,² how do you move that to the political need to organize and operate differently from how we are today but similar to the ways in which humans have operated in the past and continue to operate in the present in different ways? For me, that means less individual and more communal ways. How do we come together to do particular things, given the way that we've come together in the present, which is a result of all these movements and forces that move people organisms around the planet and also move the planet both literally and metaphorically.

What does it mean to do this work in the space of math education? There is already a strong socio-political, socio-ethical dimension in mathematics education—work from over the last four decades, at least, and perhaps even longer. It's always been aligned with this idea of opportunity, whether that's economic opportunity or other types of opportunities. In this case, it's being *for* flourishing. In the years leading up, the work of mathematician Francis Su struck a chord with lots of people. I entered the field through Martin Seligman's concepts from positive psychology and flourishing, even though I don't think Francis uses them. They are concepts that make sense to me. Psychology has very much focused on

²For example, STEM, STEAM, STREAM, STEMSS, SAMBA, etc.

pathology for quite a long time, but there is another side to being human which is being well, so how do we shift our attention to do that as well, to make that a focus or goal of ours in teacher education.

The fact is that the beginnings of focusing on the human haven't always forced us to act or be compelled to organize. Spending time in Alberta, in particular, with Indigenous, First Nation, and Metis colleagues (I don't think I had the good fortune to meet any Inuit colleagues), with scholars doing really important work, like yourself, Florence, Trudy, Sharla, and Brooke, we've been challenged in that way and in a very particular landscape that is Alberta, Edmonton, with the mountains and the plains. As well as being away from home, looking at what's happening in the Caribbean and to other small island nation states, I've been thinking again about the more-than-human or the other-than-human, not in a salvific way but in a partnering way. For example, in thinking with bees, we partner by altering the landscape or altering it back, to invite those relations that are also necessary for well-being and survival in ways that it's not just simply the number. It absolutely and very much is a continuation of ethics in math education; it is a move toward a multi-species, planetary-type ethics rather than a human-centric ethics of how we relate to other humans only through our disciplinary apparatuses.

Marc Higgins: I really appreciate the notion that focusing strictly on the human doesn't always leverage the kinds of openings that might be desired. Here, the notion of mathematics education as being actively shaped by colonialisms is not a new theme in your own scholarship, drawing and extending critiques of the ways in which ethnomathematics could at once be a radical challenge, but it could also be subsumed back into dominant interpretations where it's supplemental, an otherness to be consumed or exoticized. This takes a new shape in your recent work as you take up Sylvia Wynter's notion of Man and its co-constituting vectors of oppression. Following Wynter, the *After Man* that you call for is not a temporal after, but rather a working toward a structural otherwise. This takes on particular significance when you invite us to consider the ways that STEM skills were central to plantation economics:

Land, and lots of it, was central to wealth generation at this early foundational stage of nascent state capitalism, and STEM skills were critical. Key aspects of the plantation model include the replacement of diverse native species by monocultures of economically productive ones; the transformation of diverse topographies into monographies of the grid allowing for

easier calculation rates related to yield and harvesting; and the use of cheap, replaceable, substitutable, or enslaved labour, including the labour of animals, micro-organisms, and machines and the study of any and all factors affecting yield/productivity in order to produce novelty and speed up generation time to market. (Khan, 2020, p. 237)

Further, you invite consideration of the ways that plantation logics continue to permeate and persist within mathematics education. Could you elaborate upon why this is significant, be it in terms of *who counts* as mathematics learner, *what counts* as mathematics, as well as *why* and *how* we learn mathematics?

Steven Khan: This is part of the affordances of doing a university degree in Canada and elsewhere. I stumbled into Sylvia Wynter's work while at University of British Columbia, through others' work. If I had stayed elsewhere, I probably would not have had that looking across, that looking back, that looking forward, I would not likely have had that space in mathematics education in the Caribbean itself. I would have done more traditional mathematics education and would not have had these influences necessarily at that time.

The idea of the plantation is certainly something that we talk a lot about in the Caribbean, and in a small place like Trinidad its presence is always felt (at least at the time I was growing up). Thinking back, my high school history education is mostly Caribbean history with almost no European history—European history is the one that is not heavily emphasized (this makes reading European theory harder at times) so mostly Caribbean, and with more North and Latin American history. I think back to the teachers that I had there who really took us through this step by step to understand how we came to be. We talked about the arrival of Europeans in the Caribbean and genocide, although not with that label at first though certainly with the language of population decimation: through slavery, through abuse, through labor, through disease. These changed or radically reduced the numbers of peoples in the region and then how that impacted the next part of history. This is the conversation we were having at 11–12 years old and throughout our high school years, which I think is very different from the types of conversations that perhaps happened here (in Canada). Again, it's a different society, different history. But the idea of the plantation, its logics and economics which are really significant in our region, comes out of the work of Sylvia Wynter and, in particular, economist-philosopher Lloyd Best who worked with Terry Levitt on

plantation economics. The key idea is that in plantation or agricultural colonialism, as opposed to say, settler colonialism, you are using the land over and over in order to generate profits in order to export. It's not about meeting local demand beyond that of the planter class and what is to be provided for labor. As a result, there's always scarcity on the local front where there might be abundance on the consumer front and in the emerging and expanding metropolitan marketplaces.

All this is taking place in a context of an explosion in European science, technology, engineering, and mathematics—from building ships, to navigation, to the birth of modern accounting practices, to large-scale economies. All those “standard algorithms” for the basic mathematical operations that we still use and the ones that we continue to fight over as part of what used to be called the Math Wars are spreading during this period of time, such as keeping good ledgers, for example. At the same time, there's lots that's being pushed to the sides, there are things that are going underground, and new things that are emerging. Not everyone, for example, is being taught mathematics, and not everyone at this time is being taught the same type of mathematics.

In terms of plantation logics permeating and persisting in math education, you'll be familiar with it if you've been employed at some point in North America: overwork, uncompensated labor, and scarcities. This is a conversation I keep encountering in a number of books: the plantation system is definitely premised on scarcity, or rather, it's premised on if there's scarcity, then we need this, and our goal is really to keep increasing profits or markets, moving past satisfying needs to creating desires. Math is like that, as well, at times: there's math that we need and which is part of a culture and society meeting its members' needs for survival, transcendence, dignity, belonging, and equipping them to meet some challenges, then there's math that's enjoyable, and then there's math about creating desire and manipulating behavior.

In terms of Sylvia Wynter, there's an interview with David Scott, where she talks about genres of being human and alternative genres which resonated with me. It is not about looking for a singular notion of *After Man*, but it is about looking for different ways of being and doing. Because there is nothing that this swarm of beliefs and discourses and practices hasn't touched in education, and in particular math education, which happens to the place where I do my own work. The structural otherwise is about working with others and is about just starting or even noticing what is being pushed aside by dominant discourses and epistemic cultures. It is

not a utopic “if this then this will come” so just get started. So, in terms of who counts as a mathematics learner or what counts in mathematics is definitely very much influenced by the ethnomathematics and critical mathematics programs. For me, mathematics, at its core, is really about patterns. Humans and other species do not survive and certainly do not complexify without attention to patterns and attaching significance to patterns in some way.

So *what* counts as mathematics is tied up with *who* counts in terms of mathematics is tied up with *what* mathematics *do we teach*, as well as *where* we learn, and *how* and *when* we go about doing it. The plantation system states, “here’s what you need to learn and when.” There’s no real *why* or the why is endlessly deferred. That’s changing in the last few decades with *why* being put forward around the STEM argument of economic competitiveness, around the environmental argument, or around understanding the political impacts of and participating in democracy and being a democratic citizen. However, the idea of flourishing only came about fairly recently as an explicit goal. There are lots of educators who’ve been doing that for many years differently. For example, Indigenous educators propose that we learn in order to become good ancestors, to become good relatives, and to live well in the world. This is different as well as more expansive than the Christian version of being good stewards. This distinction between ancestry and stewardship is a very different sort of relationship. Which is not to say that they do not have places of similarity and congruency, but they are grounded in different visions of the world (or creation) and our human place in it.

So, *who* counts as a mathematics learner is tied up with the history of mathematics around who’s been excluded. We’re at the point today where we now have two women who have won Fields medals, but several colleagues posted breakdown by country, showing a large number from the US and smaller numbers elsewhere. Who counts as a mathematics learner is also related to what counts: we can find mathematics, in terms of everyday, in things that are needed for survival and things that are needed for belonging, in practices that allow and promote this feeling of going beyond oneself, and in ways that are always challenging.

The key for me to mathematics is *challenge*: all species, I think, address the challenges that the environment that they find themselves in poses them in one way or another. Humans are a particularly interesting case on that tree. In the multi-species flourishing framework we place play with challenge as we think this is where it starts—the posing of challenges by

the organism that results in pleasure and learning for its own sake rather than for someone else's sake. The set of animals that engage in play keeps increasing annually. As I revise this, for example, I just read about a study examining bees who exhibit behavior that they categorize as play. So, yes, there is mathematics related to survival, but there is also mathematics that is related to challenge through play and which I think is where its potential for flourishing emerges most forcefully as a rationale for learning mathematics.

Marc Higgins: These notions of the *who*, the *what*, the *why*, and the *how* being so intertwined really speak to your recent writing about over-representation being so present in math education (Khan, 2020).

Steven Khan: Informed by Sylvia Wynter's work, this goes back to when I was doing my doctoral work and noticing, doing that listing of the people that we (were required to) study and who they are, and seeing the real focus on mostly men. There is some diversity among those men, but they were almost all men, and they were mostly in the North American Academy, with the exception of Paulo Freire.³ Then, having the opportunity to design a curriculum history course with my supervisor and being more intentional about different types of diversity in terms of our readings to bring that attention to representation and to open up to different perspectives. This is critical in this particular type of work.

Marc Higgins: This transitions us nicely. Importantly, as you consider decentering *Man*, there is an invitation to move beyond the human as "there is not and has never been human flourishing at community and population levels without—or independent of—multispecies' flourishing" (Khan, 2020, p. 239). What does it mean to address the paucity of work in STEM education which "mak[es] our more-than-human kin *central* to its theorizing and curriculum innovations" (Khan & Bowen, 2022, p. 4). Importantly, why is this significant?

Steven Khan: Regarding the first part, that there has never been human flourishing, I think about our mega-billionaires, our Jeff Bezos-es and Elon Musks, who are again mostly men; they've created systems that allow them to flourish at the expense of many others, or have capitalized on the

³ Again, coming from a different place and being a bit of a prolific reader, I was very much confused by the limited engagement with educational thought and thinkers from other parts of the world apart from North America and England, France, and Germany, which I had already encountered through, for example, <http://www.ibe.unesco.org/en/document/thinkers-education>. The absence of African thinkers, for example, was glaring, as well the limited engagement at the time with Indigenous thinkers.

systems, logics, and principles that exist to do that. So it is possible for individual flourishing to exist without multi-species flourishing, without human flourishing. This throws us back to the fifteenth, sixteenth, and seventeenth centuries and the transatlantic slave trade, and the Indigenous slave trade in the Americas. This extends into the present with what's happened in the US with *Roe vs. Wade*, this idea of personal autonomy and responsibility to a collective. Extending this is not leaving behind the human being but stating that we are not the center of this conversation. We've forgotten how to do that; we need to re-learn it in the spaces that we now find ourselves in. There is good work in STEM education that does address it. For example, the work out of the University of Hawai'i System with their STEMS,² which includes sense of place and social sciences, fits squarely in that frame of keeping our more-than-human kin central and working toward thinking about them as partners and not as resources.

I think that's the other hard part: our language is very "resource"-oriented in teacher education and in education more generally. So, one of the things I always try to trouble is this idea of resource, working toward using it much less frequently, as well as really thinking about what it means and the baggage that comes with the word resource. *Partner*, for me, or kin, is that shift in language, theorizing, and innovation.

What does it mean to address the paucity of this work? It's significant that those who do this work are often not sufficiently acknowledged in the literature. I can see lots of people doing this work who aren't academics. Again, thinking about our responsibilities, how do we share the privileges and the rewards that come from the academy, while at the same time transforming those systems of privileging and rewarding? For me, it is a reorientation toward gratitude. Here, I'm really dependent on the work of Mohawk Mathematician Edward Doolittle and others who keep reminding us that a first move in anything is to recognize and to be thankful, to know what you have received and what you are a part of. Oriented toward gratitude and sufficiency is the idea of enough. This is again another difficult concept that goes along with the resource view and the scarcity that abundance holds. Scarcity is easy to see in our education system, abundance less so. But then there are also the places where there is abundance but also waste. Universities can sometimes be places like that as well. So, it's about bringing back ways for having respect for partners, in our learning, so they are not just another set of rules on paper but rather codes in our consciousness. This is what, in the old world, we used to call values

and virtues, and still do, and bringing those back to life in our actual practice and not merely ethics.

Marc Higgins: In terms of phrases that really landed with me, as I was reading your work, is this notion of sensible and sense-able, to be able to sense, as they relate to quantitative literacy. One of the themes which permeates the first volume of *Reimagining Science Education in the Anthropocene* is that perhaps “the Anthropocene(s) need new ways to be felt” (Wallace et al., 2022, p. 6). As you state, “science and mathematics have their own poetics and construct powerful mythologies even if it might be difficult to conceive of [their] language ... as *also* poetic language” (Khan, 2011, p. 16, emphasis in original). In making the Anthropocene(s) sense-able, our responses sensible, we might need to calibrate our attunement otherwise: “mathematics, while able to describe and give a quantitative accounting of the magnitude of the planet’s loss in its ledgers, perhaps has no language yet to audit such mourning” (Khan, 2020, p. 231). This might require differently attending to this moment’s poetics, its silences, and rhythms. Can you elaborate upon the ways in which this quantifying must go beyond a more robust and reliable form of quantifying the world (e.g., inspire new ways of listening, mourn the innumerable and unquantifiable losses marked by the many end-of-the-worlds which co-constitute this one)?

Steven Khan: This question about new ways for the Anthropocene to be felt and sensibilities/sense-abilities is a conversation I’ve been having with Mike Bowen. One place we started together was Bernie Krause’s soundscape ecologies, which is about recording the same landscapes at different times. One example is Sugarloaf Ridge State Park, where there’s been intensive logging, but looks the same from the road. However, the bio-phonic signature between years is radically different: you hear this *silencing*. The way to knowing, noticing the pattern, and thinking about the implications all go together. It’s good drama in that it doesn’t give you all the details. It leaves enough space for you to have to fill in those gaps, or good horror as it doesn’t show you everything. It leverages what our cognitive and emotional systems are meant to do well: fill in gaps. That led us into talking about people who work on sound science and bio-acoustics, and he shared a researcher’s work on hearing rainfall patterns across different states in the US to hear how that’s changing plant distress. I shared work on hearing sounds in the soil. Again, things that we don’t really think about a lot.

Returning to the idea of merging, of synesthesia, of multi-modality: if we think of what we actually know right now, we know our brain functions

best with multi-modalities. There are times where we want to focus only on one modality, but we are embodied creatures who are working with many modes of engaging with and experiencing the world. I remember reading years ago about work on nerve conduction: when we hear, the time for the signal to go from here to here is a lot faster than from the eye to the brain, so we hear a lot faster than we see, even though the light travels faster than sound. Even in the absence of hearing, most species, or maybe all species, respond to vibration. They have vibration sensation mechanisms. This is another thing that unites us. You can think about what we would classify as non-living within traditional biology, but even rocks resonate. They have vibration sensitivity, even if it is not the same response-ability toward those vibrations.

This type of work involves collaboration to really think through, as these are not places where most of us in education have expertise, be it in technology or in sound and visual engineering. For example, I think that sound engineers and other artists, I would put them within STEM as well. There's work, for example, with film and game studios, who have ways of affecting us and orienting our attention to these end-of-the-worlds. There's *WALL-E*, as one example where there's not a lot of human sound for a while, and the satire that came out earlier this year, *Don't Look Up*. I think our ancestors, our Indigenous partners, as well as our non-human partners have things to teach us about how to attune and what to prioritize in terms of what's necessary for well-being. Again, this requires us to slow down.

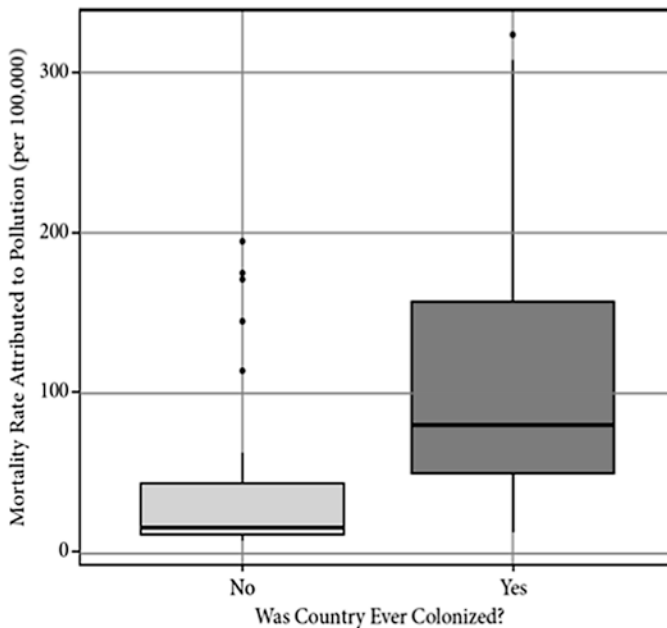
Another example here is whale song and how it literally moves the oceans, not just metaphorically. The water is the medium, similarly to how we don't see the air moving. Some whale sounds can travel thousands of kilometers, a great distance in the ocean. But what happens when that sound disappears? We have that silencing, that loss of movement, that stillness. This is what it means to go beyond a more robust and reliable form of quantifying the world.

Nora Bateson's work on warm data, for example, is where I think our work needs to go: making our data more relatable, partnering with our data, and partnering with our multi-species kin in the data-making process. Again, I think about some of our Indigenous colleagues and their traditions: for example, the winter count. This is very different from the annual report that we have, but I'm not really "partnering" with this computer to do that. The significance is not in this partnership. Whereas, in traditional winter counts, hides and other record-keeping devices are very much tied to animal partners, to plant partners, to other human partners,

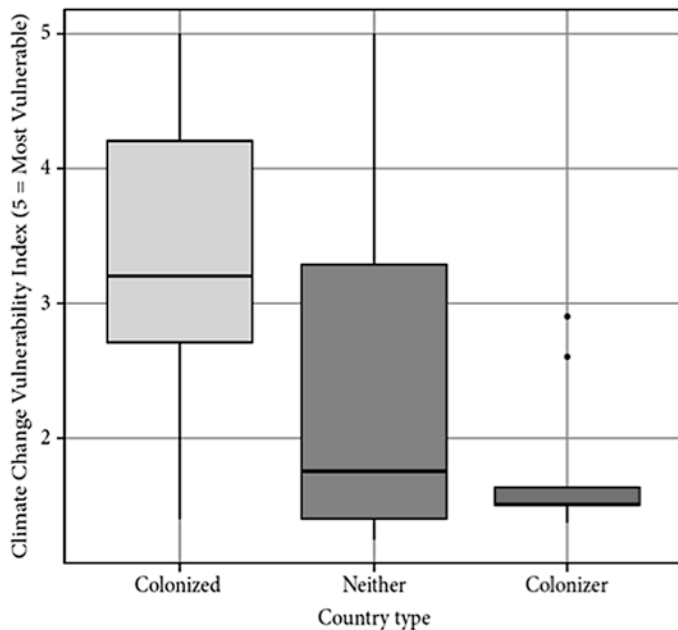
as well as quipu used by the Incan and other Andean cultures. Winter count involves a lot of plant partners, as well as time, slowing down and remembering. We can make quipu for these unquantifiable numbers: What would that look like? What would it feel like? How long would it take to actually represent that loss? I'm going to go with a billion for the number of sea creatures lost in the last year in British Columbia due to heat. How long would that physically stretch out in order to represent that?

I think that both our Indigenous colleagues and our colleagues who are the descendants of enslaved people have a lot to teach here, in particular, around that mourning of unimaginable loss while continuing to move forward, as well as responsibilities for reparation, for reconciliation, for new partnering.

This box plot is from *Reconsidering Reparations* (Táíwò, 2022). I very much now feel sadness for not appreciating just how under-represented and underappreciated box plots are. These two plots function as a visual poem: one is around how pollution is distributed based on whether a nation was colonized and the other is on how climate change vulnerability is distributed across colonized and colonizer countries.



How pollution is distributed



How climate vulnerability is distributed

Marc Higgins: When we talk about poetics, the meaning is made in the in-between space. Importantly, you are moving this work into your teacher education practice. Could you share some considerations that you bring for doing this work in teacher education? For example, in Khan et al. (2021) you speak to the importance of explicitly framing what might promote, limit, and work against multi-species flourishing, as well an attentiveness to the already present and existing ecologies of practice pre-service teachers bring with them.

Steven Khan: I will start by stating that I am operating from a position of a lot of ignorance (not intentional but just a humble recognition that there is more than one will ever know in a lifetime about most things); that's the place that I start from. Secondly, there things that I think I know very well and so there is appreciation for what I do know and the value of that. I don't fully understand the workings of teacher education here in Canada and the US and am constantly puzzled by its promotion, organization, administration, all those elements. The scale is different for me, here in Canada than from the Caribbean, where you typically meet teachers over and over again as there is less movement and the range of

movement is smaller given the size of the islands, and so part of this is appreciating the continental-ness of Canada versus the island-ness of Trinidad. Even different institutions in Canada have different degrees of constraints in terms of what you can actually do. There are fewer constraints on what you can imagine doing. In reference to the Khan et al. (2021) piece, and the other work we've done when we started planning our course, we framed it in a three-column table:

flourishing-promoting, flourishing-limiting, and flourishing-extinguishing.

For example, social-emotional learning would be under flourishing-promoting as well as things that encourage joy, persistence, and challenge. What can we bring in under that first rubric? Things such as arts, movement activities, community involvement. Flourishing-limiting is where difficult conversations come in around things like racism, sexism, able-ism, pretty much all the -isms, scarcity, and other things that have long-term and wide-ranging systemic and individual effects. These reduce the probability but doesn't extinguish the possibility of flourishing; anticipating the argument of *What about this particular case?*, for example. How do we address those? How do we bring those into the conversation? It's not the only focus, but it is part of the conversation. For example, in my work, I typically don't do as much on gender diversity and sexual orientation as I do with respect to racism. However, that's an area that I can grow, and I add a bit more to that, over time; this is not my area of expertise and deep knowledge, as well as lived experience in that way. The third and last category of flourishing-extinguishing includes things like murder, genocide, genetic, or linguistic extinction, the unmaking of worlds. These are our Thanos-level events. One of the things that I do, for example, is lay out the characteristics of genocide: does what happened in place X or Y meet these criteria? It's an analogy to common geometry practices: okay, here are these characteristics of the rhombus, is this shape a rhombus based on its characteristics? It's about taking the idea classification to a different place and to recognize that the classifications skills we learn aren't only about mathematical objects. And it's not about thinking about genocide as a mathematical object but about thinking about genocide using skills and tools that we've learned in mathematics, through those habits of mind. These are not meant to be sharp categories. For example, war is hard to place. It is probably closer to flourishing-limiting than -extinguishing depending on the type of war. Climate change is probably closer to flourishing-extinguishing, but it's not completely in that category.

For teacher education, this means bringing in these conversations in ways that are meaningful, with pre- and in-service teachers as well as administrators, that we don't shy away from them.

I'm really excited to potentially be teaching an ethnomathematics course this year that really would be taking up some of these within that frame. [Well, only four students registered, and so the course did not run ... in the logic of our current academic system where it is almost impossible for something like this to grow or establish itself unless it already starts with some mass appeal. So even though this is something that teacher candidates and teachers have said they want more of ... for a variety of reasons when offered it can't even gain a foothold as yet. And if it fails to run the second year will be likely not to be offered for at least one year or more.]

Marc Higgins: Something that struck me as I was reading the Khan et al. (2021) piece was attending the ecology of practice that pre-service teachers already bring with them. I'm still learning a lot about teacher education as well, but there's a piece that stuck with me about aggressive and tender navigations: what does it mean to care for the individual while simultaneously critically and aggressively working the structural (Galman et al., 2010). I get that sense in reading your work that you recognize that they come from a particular place and inquire into what it means to care for teachers, where they come from, while still working with them toward something that might be more flourishing-promoting for themselves and their students, as well as their greater human and more-than-human communities.

Steven Khan: In the North American context, pre-service teachers have been learning about teaching and learning from pre-kindergarten: they have ideas of what that means, their communities have ideas about what that means. I don't have that same lived experience, though my daughter will; all I can do is really note how it is different and how it has really been radically different across the height of the pandemic. Teacher education is this potential space in which we could talk about those things, but we perhaps don't as much as we would like to or they get pushed off to smaller, more emerging-type spaces. In that frame, students have histories, they have things that they are experts in that they don't know they're experts in. For example, the practices of folding, packing, and putting on headscarves; any type of practice where you work with measurement with the body, such as sewing, cooking, etc.

Marc Higgins: I really appreciated how Hang’s sharing about making *Bánh Chung* generated a slew of student comments in which they came to seeing themselves or their own cultural or traditional practices as having always been mathematical but not registering as such because of the ways over-representation functions.

Steven Khan: I can’t say that all students took that away, but the idea that “Okay, this is a not a practice that you can engage in in the classroom, this is not your tradition necessarily. If you want to do this, then you need to find a partner.” That’s where I want them to go with this, as opposed to, “Oh, this is a resource I could take into the classroom” because they might not have the intentionality and understanding that the person who is steeped in this culture can. That’s not the place you want to end up, as this often ends in ways that are hurtful at the minimum and offensive or harmful at its worst.

There’s a piece coming out that talks more about the caring part, which is work that I’ve done with Stephanie LaFrance around curating as a deep caring for. The period for which again Caribbean, and other migrations, when we think about all these migrations we have these things that people hold on to because they care very deeply about them. Like the practice of *Bánh Chung* and all the other parts of the New Year celebration, not just the practice of *Bánh Chung*.

When we think of one math education within the plantation system of teacher education, we offer resources rather than things to care about. How do we teach care? Recognizing that you don’t have to care about the same things I care about, nor in exactly the same way. But we should know what each other cares about and how to care for those things well in this space, as well as little humans and other-than-humans. I have some teachers that I taught in the past, I have no responsibility for how good they become, but who do that type of work: for example, showing pumpkin decomposition by having it in a container in the classroom, naming it, and observing it decomposing over time, and reflecting on the process. In the spring, they took it outside and put it back into the ground. So, this is something this teacher cares about and is trying to communicate how you care about that: without faking it.

Marc Higgins: I think it’s a fair statement to make that your recent work (e.g., Khan, 2020), which creatively weaves decolonial theory, Indigenous mathematics, and multi-species thinking to critically respond to mathematics education in this particular moment marked by a “we” of climate crisis that erases the ways in which multiple human and

other-than-human communities are unevenly impacted (and the ways in which this particular Anthropocene is predicated on multiple others, in ways that are marked by [attempted] genocide), speaks to a long-standing commitment to fostering collectivities: allies and alloys. As you stated early on in your scholarship, “the field [of mathematics education] must find allies and alloy itself with disciplines and perspectives in which the imagination is central if it is to address or redress some of the inequities and injustices of the present” (Khan, 2011, p. 17). This is not only evident in the ways in which you’ve worked from and woven together multiple and often disparate fields, such as ethnomathematics (e.g., Khan, 2011) and environmental education (e.g., Karrow et al., 2017), but also the multiplicity of different collaborations that you’ve sustained and lifted (which more recently include working with folks in science education; e.g., Khan & Bowen, 2022). Can you speak to the importance of “allies and alloys” in your (collective) work?

Steven Khan: I was a secondary school biology teacher, so that remains a strong influence in terms of how I conceptualize allies: math and biology folks are those I chat with the most. Allies is pretty straightforward in that we all need communities of belonging and to feel a sense of belonging, for a variety of reasons. We need to feel part of communities. Part of this comes from this deep sense of academic loneliness that begins in different places and continues. I don’t like to think by myself; I like chatting with students and colleagues. When I find people I like to write with and work well together, that is an extension of the talking with. When I wrote that piece (Khan, 2011), allyship was also about discipline. It was stating that curriculum studies and math education did not talk a whole lot to each other, but this argument is not exclusive to this context.

The idea of alloys comes from chemistry, not my favorite discipline: the calculation part great, the actual lab stuff less so—I don’t think I was very good at titrations. It’s also a variation on notions of identity, like creolization and intersectionality, but in the compound sense, rather than the cumulative, collective sense. We are not a collection of identities, which some versions of intersectionality frame it as. Rather, we are a *compound* of identities: that the thing we are now can’t be disentangled, can’t be re-decomposed into these individual constituent parts. We are all, and it is always, something new. This entanglement makes unitary locations and positionings impossible. The idea of alloys is also meant to bring to mind energy, forces, and spaces, and involves things like heat, light, sound, and crucibles. Although I don’t think I’ve ever worked with a crucible, in

terms of their real smelting processes, at least not yet. This is very much related to ideas, the history, and evolution of the steel pan movements, so working with alloys there. The description I offered in that piece, from Leroy Clarke, was about what it means to write poetry: to read words until they give off flavor, color, and scent. So he's also drawing on the idea of the steel drum: yes, you're hearing it but you're hearing it with your whole body, as there is a visual, gustatory, and olfactory element to the music. After becoming a parent, this gives us another example, although I don't think our partners would appreciate us calling our children alloys—so don't use that one! They are an admixture of two and more than two and that the result is one and more than one.

The idea of allies and alloys also comes out of some of the work of maroon theory and maroon mythopoetics in the Caribbean, with the idea of allies struggling against the plantation system. Welcoming not only those fleeing the plantation if they were enslaved or freeing others from the plantation but also welcoming those cast aside by the capitalist system. Often, if the sailors were injured, they'd be abandoned on one of these islands and left—or if they got old or sick. There are allies and alloys to be made with disability studies and other fields: these are the communities that are currently struggling against the plantation system, its logics, economics, and religion. So, how do we ally ourselves with them in terms of learning, organizing, and doing? It's also about speaking to the culture of mistrust, protectionism, and secrecy that's part of the DNA of the Academy that works against relationships in order to protect the integrity of your scholarly words.

Marc Higgins: Are there any closing thoughts that you would like to add to this particular interview at this juncture?

Steven Khan: Bringing together a number of things: for me, I think the multi-species flourishing idea resonates with people in ways that other discourses don't, where there is still that possibility for collapsing into some other discourse. [I recognize in it a variation of one of my initial concepts, that of inter-vulnerability, but I think flourishing seems to work better than vulnerability.] For now, I think it's managed to hold the conversation open a little to give pause: to go hmm, that's not something I've thought about or framed it that way. However, it is something that I think many people have thought about and are engaged with in different ways. It's continuing to expand as well.

I don't think I'm an organizer, but I think this is the next part: attending to others' writing and others who find themselves in particular

histories and locations, making that choice to do that type of organizing work. Setting others up to take it up and do good things with it.

Marc Higgins: This also speaks to the ways in which we're all differently gifted. We all flourish when plurality is welcome rather than rendered a liability.

Relationships matter; ... relationships with our more-than-human kin matter; and ... learning mathematics, science and technology for survival, transcendence, dignity, belonging and to meet challenges through studying the networks among land, language, lore (story), living, logics and (emergent) learning is a necessary first step in repairing relationships damaged through the various forms of colonialism (settler, extractive, plantation), ongoing colonialities and its attendants—racial capitalism and multispecies exploitation. (Khan & Bowen, 2022, p. 7)

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