

FRACTIONAL HUMANS: HOW DECOLONIZING THE LEARNING OF MATHEMATICS CAN HEAL

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Mathematics is often regarded as abstract and culturally neutral, a world unto itself. Fractions, for example, allow us to mathematize beyond the limitations of integers. However, fractions are not abstract for those who live by, and within, particular cultural and political strictures. Fractional lived experiences may be comfortable and normalized when they reflect dominant cultures, or visceral and exclusionary when they do not. Our work as an Indigenous mathematics curriculum research group began with considerations of Indigenous fractional contexts. We quickly realized the problematic nature of many Indigenous fractional experiences. Here we share problematic contexts, interwoven with the lived fractional experiences of Indigenous folk in what is now known as the United States. We conclude with an argument that to decolonize the learning of mathematics we must recognize and invite students, in their entirety, into mathematical apprenticeship. An Indigenous mathematics curriculum is one of many portals to a decolonized mathematical future.

We argue that mathematical words and contexts are cultural. Mathematical words and contexts, thus, may have very different meanings and impact for different learners. Mathematics education is a social endeavor, interweaving people, concepts, contexts, and conjectures. We come to know mathematics through our own metacognitive experience and understandings of how others make sense of mathematical problems. Mathematics instruction is accountable for the ways students are (and are not) fully invited to be knowers and doers of mathematics.

We are members of the Ichishkiin Mathematics Project research partnership working to develop mathematics curriculum in an Indigenous language (Ruef, Jacob, Walker & Beavert, 2020; Ruef, RunningHawk Johnson, Jacob, Jansen & Beavert, 2020). This work grows within the nexus of western and Indigenous worldviews and languages. To learn mathematics is, in part, to *identify* with it (Heyd-Metzuyanim, 2017; Ruef, 2020). How do we see ourselves, and others, reflected in mathematical concepts and argumentation? How do we relate to the knowing, doing, and learning of mathematics? Our focus on fractions, as they emerged from mathematized Indigenous contexts, brought to light an unexpected question: What does it mean to fractionate a human being? The answers depend on who is asking, and who is answering the question. Sometimes fractional parts add to a whole, sometimes they do not. These questions inevitably involve power, and the history of power relations that shape the question askers and answerers.

Dominant identities are often taken for granted, easily lost in their perceived normalcy. To illustrate contrasting experiences of fractionated identity, we begin with a white citizen identity before shifting the focus to our central concern: Indigenous identities that have been violently fractionated by settler colonialism. We return our attention to how identities must be considered in the learning of mathematics. We begin our discussion with a brief history of the fractional identity experienced by Jennifer. Michelle's stories are shared in her writings (Jacob, 2013; 2020a; 2020b).

Fractional humans: differing experiences of settler colonialism

Jennifer grew up secure in the family lore that while she was a full citizen of the United States, she was also ethnically half Norwegian, half Swiss. She attended public schools in what is now known as central Wisconsin, and her second-grade curriculum included units on the cultural heritage of each student—based on a survey of the ethnicities of the class. The results indicated all the children were of European or Asian descent. For birthdays and holidays, her mother made *krumkake*, a Norwegian waffle cookie, using her grandmother's special iron. Her grandmother made *lefse*, a flat bread made from potatoes. When Jennifer turned twelve, her family presented her with two keepsake dolls—one in traditional Norwegian girls' clothing, the other in traditional Swiss girls' clothing. Summers included visits to the family dairy farm, in those days run by an aunt and uncle. The Swiss side of the family kept a pair of tiny *leiderhosen*, leather breeches worn by her father as a toddler. There were copper cowbells and edelweiss flowers mixed into the families' bric-a-brac. In these ways, culture was braided with genetic inheritance—Jennifer was half this, half that, and fully (white) American because that was who she was raised to be, via family and cultural interactions. In these ways, her cultural inheritance, as she understood it then, was completely normal and a point of pride at best, unproblematic at worst.

Jennifer's fractional identities felt natural. They reflected a dominant group in the United States, and in her youth, there was no reason to experience them as anything but normalized. This experience, in a settler colonial context, is not universal. In particular, the ways Indigenous peoples of what is now known as the United States regularly encounter questions, restrictions, opportunities, and judgments based on

their claims of fractional belonging. Through this process, one's fractionated identity can lead to a feeling of being less than whole. In his essay 'How Native American is Native American enough?' novelist Tommy Orange, (Cheyenne and Arapaho), makes clear how scrutiny of fractional belonging can be problematic.

I'm not trying to be more Native than I am. Less white than I am. I'm trying to be honest about what I have to include. More often than not I've introduced myself as half Native. I know what people want to know as soon as I say that I'm Native: How much? I watch them wait to see what I'll say about it. They don't want to have to ask, and they know I don't want to have to say it. They're testing me that way, so when the quiet between us becomes too much for me, I mumble out the side of my mouth: *From my dad's side*. The other half of me is apparent. My skin is light and I have freckles. I'm brown around the summer months and whiter in the winter. But I look like my dad if you saw me next to him. We have the same head and body. Same barrel chest, same nose. I reference my dad when I bring up being Native because I'm always doing it, qualifying my quantity. My amount. Where it comes from. And it's never enough. Too many claim great-grandparents. People are tired of hearing about great-grandparents, and great-great-grandparents even more so. It's too much math. Do I think we shouldn't include smaller fractions in the definition of what it means to be Native? I don't know. What I do know is that if I don't include the amount that I am, people assume less. So if asked whether or not I'm Native, I say yeah, and then, maybe sadly, maybe with assertion, maybe both, I say: half. [1]

For Orange, culture and race are points of pride at best, a mathematics of judgement and sadness at worst. These questions and issues may seem to be about one's personal identity, but they are in fact deeply rooted in historical and economic relations established through the violence of *settler colonialism* in a *settler colonial nation state* (Wolfe, 2006). The notion of fractional identity can uphold or partially dismantle power relations in the settler colonial state. Typically, fractional identities are founded in the greed, violence, and eugenic logic of the settler colonial state, in which the United States (the settler colonial state we focus on here) sought to eliminate Indigenous peoples (Saito, 2014). Thus, historically, when the United States created rolls of Tribal members for each sovereign Indigenous Nation, federal agents would judge whether a person was 4/4 or 'full blood' Indian, 1/2 or 'half blood' Indian, 1/4 or 'quarter blood' Indian, and so on. The United States War Department, and later the Department of the Interior, are the federal government agencies that defined and tracked these fractional identities, with the intention of dispossessing Indigenous peoples of lands and resources. In contemporary times, Tribes have the authority to define their own membership criteria, and can choose to do so by blood quantum, following the example of the settler state. Enrollment criteria by blood quantum is a controversial issue, both socially and legally, in Indigenous communities. Whether it is intended or not, children who

have lower blood quantum are given messages, implicit and explicit, that they are somehow 'less Indian' because of a fraction written on a piece of paper. In order for these damaging logics to continue to operate and have power (or be challenged), all members of a society must have a basic understanding of fractions. What, and who, gains or suffers by scrutiny of fractional belonging?

Indigenous mathematics curricula

Fractions are thus not a value neutral concept, given the long and damaging presence fractions have had in Indigenous communities. Our research group interrogates cultural mathematical contexts and engages with Indigenous cultural teachings as we construct curriculum in Ichishkiin, an Indigenous Yakama language. Our work joins that of other researchers creating mathematics curricula centered on Indigenous languages and world-views (e.g., Donald, Glanfield & Sterenberg 2011, 2012; Kisker *et al.*, 2012; Lunney Borden, 2013; Meaney, Trinick & Fairhall, 2009, 2013). Though, as research partnerships, we work in different nation-state contexts, we share common relational principles with research groups doing similar work around the world:

Research partnerships are composed of varied expertise specialists and stakeholders

Intentional flattening of implicit power structures (e.g., settler colonial logics and western mathematics)

Centering Indigenous world-views and languages in the production of mathematical vocabulary and curricula

Yakama Indigenous homeland is situated on the plateau surrounding Nch'i-Wána, the big river now known as the Columbia River of the Pacific Northwest. We write 'now known as' because the more commonly used geographical names attributed to the spaces we occupy are often settler colonial names, the residues of invading peoples who conquered via violence, invasion, and policy. Specific to our observations of fractional contexts, while a Yakama person might identify with a particular family or community, Yakama peoples did not fractionate one another. A person was a person and relative—whole unto themselves, whole unto their people, with responsibilities to take care of themselves and Mother Earth (Beavert, 2017).

Indigenous fractional contexts

Our current curricular work centers on fractions, with mathematical roots in the comparison of numerator to denominator, and the actions of counting and accounting by fractional units. However, here we turn to examples of Indigenous embodied and lived fractional experiences. We began with Jennifer's story, which is the story of a white woman; this positioning was intentional to provide a model for white readers to consider the ways in which their own identities are fractional. We believe such reflective work is necessary in order for dominant culture readers (and math educators and researchers) to be prepared to move away from white-centricity, and honor the stories of Indigenous peoples' lives.

Fractio: Breaking

The word fraction has a latin root: *fractio* means breaking. The western mathematical usage of the word fraction may mean many things, such as naming quantities that are not whole numbers or non-integer measurements along a continuum of real numbers. Mathematical concepts such as fractions are often thought of as value-neutral; however, we urge a deeper analysis, one that does not “assume teacher subjectivity is rooted in Whiteness” (Daniels & Varghese, 2020, p. 61). For Indigenous peoples of what is now known as the United States, when settler colonial policies of blood quantum measurement were imposed to define boundaries of community membership, fraction literally meant the breaking of identities into quantifiable measures of belonging. And measures of belonging, to this day, gate access to limited resources, meted out by the people and policies of a conquering nation. This happens on a macro level, robbing entire peoples of land and resources, and on a micro level, creating divisions and shame within families and communities (Gibeaut, 1999).

Fractionation of land

As the United States government created new laws and policies to remove Indigenous peoples from their lands, such as the Indian Removal Act of 1830 and the Morrill Act of 1862, Indigenous peoples were forced onto reservations and diminished ‘grants’ of land ownership. Ownership was further restricted to the descendants of the grantees, which created an exponential problem of sharing known as *fractionation*: “the problem of multiple co-owners sharing many miniscule, undivided interests in a single tract of land” (Shoemaker, 2003, p. 729). Across generations, the same land is shared by more and more people. Worse, Indigenous peoples were deemed insufficiently ‘educated’ to tend to the demands and profits of landowning, as defined by colonial logics (Gibeaut, 1999, p. 41). The federal government awarded to itself fiduciary custody, and took on the patriarchal role of overseeing the financial accounts of reservation lands, leaving Indigenous peoples as literal wards of the state. Record keeping was not transparent, and the system was rife with thievery, forcing generations of Indigenous peoples into poverty, with both lands and identities destroyed through the use and application of western notions of fractions. This repeated resource theft is visible today in the higher rates of COVID-19 infections and related deaths within marginalized communities.

Fractionation of land and people

Christina Castro (Jemez/Taos Pueblo, Chicana), is a scholar of social transformation and justice studies. As an Indigenous woman, she faces the fractionation of person and place.

So here’s the dilemma I currently face: As the oldest grandchild and the only one who participates traditionally, my grandmother wants to bequeath me a small, yet incredibly beautiful parcel of land that was given to her by her stepfather who raised her. However, because I am not enrolled in her tribe, rather my grandfather’s, I could not feasibly inherit said land unless I disavowed

my status in my other Pueblo and enrolled in hers; that is if they would even accept me. Furthermore, since I am only $\frac{1}{4}$ blood quantum of said Pueblo (the minimum amount required for tribal enrollment), even if I were to enroll there and inherit said land, unless blood quantum criteria changes or expands, the land would fall out of my hands anyway once I die, lost to our family forever. [2]

Orange and Castro’s stories are far from unique. The stories of Indigenous peoples of what is now known as the United States are far from unique. Settler colonial logics continue to dispossess Indigenous peoples by any means necessary in order to uphold settler colonial supremacy (Tuck & Gaztambide-Fernández, 2013). The idea and application of fractionated identities and lands serve to strengthen settler colonial logics and white supremacy in the United States. Federal policies, such as the Bureau of Indian Affairs standard of $\frac{1}{4}$ blood quantum, as well as enrollment being limited to one Tribe, establish the conditions that continually dispossess Indigenous peoples, and have done so for generations.

Native Americans make up less than
one percent of the population of America.
0.8 percent of 100 percent.

O, mine efficient country.

I do not remember the days before America—
I do not remember the days when we were all here.

Police kill Native Americans more
than any other race. *Race* is a funny word.
Race implies someone will win,
implies *I have as good a chance of winning as—*

We all know who wins a race that isn’t a race.

Native Americans make up 1.9 percent of all
police killings, higher than any race,
and we exist as .8 percent of all Americans.

Sometimes race means run.

I’m not good at math—can you blame me?
I’ve had an American education.

We are Americans, and we are less than 1 percent
of Americans. We do a better job of dying
by police than we do existing.

When we are dying, who should we call?
The police? Or our senator?

At the National Museum of the American Indian,
68 percent of the collection is from the U.S.
I am doing my best to not become a museum
of myself. I am doing my best to breathe in and out.
I am begging: *Let me be lonely but not invisible.*

In an American city of one hundred people,
I am Native American—less than one, less than
whole—I am less than myself. Only a fraction
of a body, let’s say *I am only a hand—*

and when I slip it beneath the shirt of my lover,
I disappear completely. [3]

Decolonizing the teaching and learning of mathematics

What does fractional identity have to do with the learning of mathematics? Plenty. Poet Natalie Diaz (Aha Makav) writes of the intersections of Indigenous and American identity, mathematics and education, in her poem ‘American Arithmetic’ (2020, p. 37 see facing page).

Diaz’ descriptions demand a reckoning. A reckoning of the ways fractionating policy can damage. A reckoning of disparities in treatment, outcomes, distributions of resources to people. A reckoning of how individuals come to see themselves (and not see themselves) as valued, welcomed, protected.

Because it is a human endeavor, the learning of mathematics takes place within the intersections of identities and contexts. When we invite students to join the apprenticeship of knowing and doing mathematics, we invite varying degrees of their humanity. Historically, mathematics education has favored speakers of the dominant language, those quick to answer, those who make fewer mistakes, those who are lighter skinned, those who are male. Reflective educators must ask themselves: Do I invite the whole student, or ask them to check some piece of themselves at the door? (Ruef, 2020). Do I communicate that my students are capable and competent, or less than and broken? (Goins, 2017). Educators who seek out and highlight the brilliance of students engage in wholistic and healing work.

Colonial logics brutalize and break people, literally, into fractions. Fractions of Indigenous blood quantum. Fractions of sovereign homelands. Fractions of land ownership, divided so as to be readily stolen. This was and is devastating work. Yet, by analyzing and critiquing it, we can encourage resistance of these damaging logics (Jacob, 2013).

As a research collective, our work is centered on the decolonization of the teaching and learning of mathematics. There are many ways to heal the world, and we begin with a stance of centering Indigenous ways of being, knowing, and doing, in service of teaching and learning mathematics. We consider identity, the ways people may see themselves, and others, reflected in shared mathematical work. Our work braids Yakama and Ichishkiin worldviews with western mathematics in ways that invite Indigenous students to see themselves reflected in mathematics, and non-Indigenous students to appreciate a culture and language that may be new to them. Instead of upholding knowledge regimes of division and diminishment, we suggest returning to Indigenous perspectives of relationality, which both invite and demand respectful relationships with each other and all of our more-than-human-relations (Beavert, 2017; Jacob & Runninghawk Johnson, 2020). This is healing work.

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Notes

[1] How Native American is Native American enough? *Buzz Feed News* (5 June 2018). <https://www.buzzfeednews.com/article/tommyorange/tommy-orange-there-native-americans-indians>

[2] What does the future hold for a growing mixed-blood population? *NDN Collective* (6 January 2019). Online at <https://ndncollective.org/what-does-the-future-hold-for-a-growing-mixed-blood-native-population>

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