

# Miscalculations: Decolonizing and Anti-Oppressive Discourses in Indigenous Mathematics Education

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## **Abstract**

In North American mathematics education, many practitioners highlight a disparity in achievement between Indigenous and non-Indigenous students, and claim that incorporating Indigenous perspectives in mathematics provides a more inclusive teaching approach. However, our analysis shows that there is a stream of North American practitioners who do not use anti-oppressive or decolonizing discourses, including those who claim to be motivated by social justice education. By avoiding or not emphasizing colonization, ongoing racism, and oppression in Indigenous mathematics education, these practitioners are perpetuating a false sense of the origins of inequality. Furthermore, the quest for Indigenous cultural connections in mathematics sometimes has consequences such as

placing blame on Indigenous peoples for not being authorities on their cultures, perpetuating stereotypes, homogenizing Indigenous cultures while reducing their history and knowledge to superficial artifacts, and preserving a sense of the inferiority of Indigenous peoples when it comes to understanding and learning mathematics.

*Keywords:* mathematics education, decolonization, Aboriginal education, anti-racism, anti-oppressive education, colonization, teacher education, Indigenous education

## **Des erreurs de calcul : les discours de décolonisation et anti-oppressifs dans l'enseignement des mathématiques aux autochtones**

### **Résumé**

Dans l'enseignement des mathématiques en Amérique du Nord, bon nombre de praticiens soulignent l'existence d'une disparité entre les élèves autochtones et non autochtones quant aux résultats scolaires et soutiennent que l'incorporation des points de vue autochtones dans les mathématiques donne lieu à une approche pédagogique plus inclusive. Notre analyse montre toutefois qu'une kyrielle de praticiens nord-américains n'ont pas recours à des discours anti-oppressifs ou de décolonisation, notamment ceux qui se disent motivés par l'éducation à la justice sociale. En évitant ou en ne mettant pas en évidence la colonisation, le racisme persistant et l'oppression dans l'enseignement des mathématiques aux autochtones, ces praticiens perpétuent une fausse impression sur les origines de l'inégalité. En outre, la quête de liens culturels autochtones en mathématiques entraîne parfois comme conséquence, d'une part, le rejet du blâme sur les peuples autochtones dont le manque d'autorité vis-à-vis de leurs cultures aurait eu pour effet de perpétuer des stéréotypes et d'homogénéiser les cultures autochtones tout en réduisant leur histoire et leurs savoirs à des artefacts artificiels et, d'autre part, la perpétuation d'un sentiment d'infériorité chez les peuples autochtones quant à la compréhension et à l'apprentissage des mathématiques.

*Mots-clés* : enseignement des mathématiques, décolonisation, éducation autochtone, antiracisme, éducation anti-oppressive, colonisation, formation à l'enseignement

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## A Note on Terminology

Throughout this article, we have adapted the terminology by Kovach (2010) who uses the word *Indigenous* to refer to Indigenous peoples and cultures, and the term *Aboriginal* when referring to a specific Canadian context. She uses the term *Western* as a descriptive term for a particular ontological, epistemological, sociological, and ideological way of thinking as differentiated from an *Indigenous* worldview. In the North American context, the Western worldview regards mathematical knowledge as being uncontested, objective, and disassociated from experience, history, and cultures. This comes from a process of abstraction, which Ferrari (2003) explains is characterized by a certain degree of generalization and decontextualization for the purpose of creating new mathematical concepts. The practice of abstracting mathematics has been used as early as Plato's time in Greece to form a distinction between sophisticated and unsophisticated mathematical practices. Cajori (1909) highlights the distinction made by Greek mathematicians between the *science* of numbers (theory) and the *art* of calculation (practice) to be respectively called *arithmetica* and *logistica*, and writes that "Plato...gave considerable attention to philosophical arithmetic, but pronounced calculation a vulgar and childish art" (p. 72). The present-day consideration of mathematics as formal and decontextualized is located in this split between science and art, which we believe is embedded in the Western worldview. However, as Kovach (2010) writes, "The purpose is not to propagate unhelpful binaries, but to point out that Indigenous approaches to seeking knowledge are not of a Western worldview" (p. 21). We explain this terminology explicitly because these words that name groups carry information about knowledge systems, ways of being, and histories of oppression and domination.

## Protocols of Place

We want to acknowledge that this article was written on Treaty 6 territory. We are grateful to be afforded the opportunity to reflect on the ways that the instruction of mathematics perpetuates what is presumed to be the failure of Indigenous peoples. Our goal is to challenge normalized practices of domination in hopes of gaining equity in the mathematics classroom. We would also like to situate ourselves in this research. Stavros Stavrou is a mathematician with a bachelor's and a master's degree in mathematics, and a master's

degree in education. He is of White settler identity—the son of a Greek immigrant (his father) and a White settler with Ukrainian and French heritage (his mother). He is currently a doctoral candidate studying narratives of experience of Aboriginal teachers and students throughout Saskatchewan. He connects his work with decolonizing and anti-racist education. Dianne Miller is a teacher educator of White settler identity who strives to be an ally in the struggle for social and ecological justice. With research interests and teaching responsibilities in place-based education, she is concerned with analyzing how practices undertaken in the name of social justice can actually reinforce the status quo.

## Introduction

Mathematics education is a broad area of research and practice that looks at topics ranging from the cognitive psychology of mathematical learning, to understanding how mathematics is used in applications, research, the workplace, and daily life (Anderson, Reder, & Simon, 1999; Fischbein, 1999; Gutiérrez & Boero, 2006; Nicol, 2002; Wedege, 2010). One particular topic that is researched worldwide is mathematical competency and achievement disparity between various social groups on the basis of class, gender, or race (Cocking & Chipman, 1988; Davison, 1992; Fryer & Levitt, 2004; Knipping, Reid, Gellert, & Jablonka, 2008; Lauzon, 2001; Nelson-Barber & Estrin, 1995; Riegler-Crumb & Grodsky, 2010; Stevenson, Hofer, & Randel, 2000; White, 2001; Yow, 2012). Ethnomathematics is an area of research and practice that considers perspectives in mathematics and education related to cultural groups, social groups, classes, and age groups, and has a political and ethical focus on cultural recuperation (Frankenstein, 1990; d'Ambrosio, 1985, 2001, 2006). In the Canadian context, researchers discuss topics including student and teacher perceptions of mathematics, pedagogy, curriculum, and teacher content knowledge, as well as the need to improve mathematical literacy, accessibility, and relatability for Aboriginal students by examining the social, political, and cultural dynamics of mathematical learning for Aboriginal students (Aikenhead, 1997, 2001; Bassani, 2008; Doolittle & Glanfield, 2007; Dorman & Ferguson, 2004; Ezeife, 2002, 2006, 2011; Glanfield, 2006; Higgs & Chernoff, 2014; Liljedahl, 2015; Liljedahl, Chernoff, & Zazkis, 2007; Jegede & Aikenhead, 1999; Lunney Borden, 2013; MacIvor, 1995; Martin, 2013; Russell & Chernoff, 2016; Smith, 1994; Sterenberg et al., 2010).

In North America, many practitioners consider the educational disparity between Indigenous and non-Indigenous learners, as well as the ways culture and language could be connected to mathematics as a way to close the gap and provide a more inclusive learning environment (Aikenhead, 1997, 2001; Aitken & Head, 2008; Davison, 1992; Doolittle, 2006; Doolittle & Glanfield, 2007; Ezeife, 2002, 2006, 2011; Graham, 1988; Greer, Mukhopadhyay, Powell, & Nelson-Barber, 2009; Jegede & Aikenhead, 1999; Lunney Borden, 2013; National Council of Teachers of Mathematics [NCTM], 2002; Nolan & Weston, 2014; Sterenberg et al., 2010; Sterenberg & Hogue, 2011). While many practitioners recognize how the teaching of mathematics can reinforce oppression (Donald, Glanfield, & Sterenberg, 2013; Iseke-Barnes, 2000; Mason, 2006; Nolan, 2009; Powell & Frankenstein, 1997; Wagner & Lunney Borden, 2010), we discuss literature that lacks anti-oppressive and decolonizing discourses in relation to how mathematics education and low achievement for Indigenous peoples are being addressed. Our critique is not specific to ethnomathematics research, but rather is directed more generally to researchers and educators who take up Indigenous mathematics education. We found a number of problematic issues.

One issue is that the disparity is typically attributed to a lack of cultural relevance in mathematics or incompatible cultural learning styles in the classroom, with some North American researchers and educators failing to acknowledge colonization and ongoing racism as the fundamental cause of inequality (Eziefie, 2002, 2006, 2011; Barta et al., 2001; Macmillan, McGregor, & Old, 2005; Nielsen, Nicol, & Owuor, 2008; Pewewardy, 2002). We believe there is a disconnect between what is taken up in mathematics education as decolonizing, anti-oppressive, and social justice discourse and the discourse itself as produced by scholars and practitioners in the fields of decolonizing education, critical race theory, and integrative anti-racist pedagogy (Battiste, 2011, 2013; Dei, 1996; Kumashiro, 2000, 2004; Ladson-Billings, 1995; Schick & St. Denis, 2003; Smith, 2001; St. Denis, 2011). To better understand this disconnect, we describe decolonizing, anti-oppressive, and social justice education (as we understand these ideas) in the next section. This gives a baseline understanding of how mathematics and decolonizing, anti-oppressive, and social justice education can be related so that we can analyze how practitioners frame these ideas in their work.

The second issue we take up is that the search for “culturally relevant mathematics” for Indigenous peoples is often superficial and thus perpetuates stereotypes, and

minimizes and homogenizes the knowledge and histories of Indigenous cultures (Doolittle, 2006). Indigenous “cultural relevance” or “Indigenous perspectives” refers to the integration and revitalization of Indigenous histories, experiences, values, knowledge, and localized content in the curriculum (Deer, 2013). Stereotypical cultural revitalization in curricula creates conflict for Indigenous peoples who are trying to reclaim their identities under ongoing colonialism (St. Denis, 2007). Indeed, according to St. Denis (2004, 2007), discussions around cultural revitalization can preserve a sense of the cultural inferiority of Indigenous peoples, and often produces them as being careless or neglectful if they are not authorities on their cultures and languages.

## **Defining Decolonizing, Anti-Oppressive, and Social Justice Education**

In order to critique how North American practitioners take up decolonizing, anti-oppressive, and social justice education in relation to mathematics, we first provide a discussion explaining these concepts. Brandes and Kelly (2004) give one of the most commonly understood meanings, stating that “anti-oppression education highlights diversity in schools and society and proposes ways of using the multiple perspectives brought forward by the diverse student population as an integral part of teaching” (p. 7). We believe this explanation is incomplete because it emphasizes multiculturalism, and fails to acknowledge and challenge root causes of social inequality. Therefore, we add that social justice and anti-oppressive education also means challenging domination, and understanding how schools play a role in perpetuating economic and cultural inequality through regular classroom discourse, student–student and student–teacher interactions, and through the curriculum—especially the ideas taught, what is held to constitute valid knowledge, and how that knowledge is disseminated and assessed in cross-cultural teaching (Aikenhead, 1997, 2001). Anti-oppressive and social justice education address issues such as marginalization (based on gender, sexual orientation, physical and mental ability, immigration status, and so on), cultural and cognitive imperialism (the universalization of a dominant group’s culture, experiences, and knowledge) (Battiste, 1986; Smith, 2001), and unprovoked violence targeting specific groups (Bishop, 2002; Brandes & Kelly, 2004; Battiste, 2011; St. Denis, 2007; Razack, 2002; Schick, 2000). These descriptions

are explained concisely by Kumashiro (2000) who writes that anti-oppressive education is education that works against situations or dynamics in which certain identities or ways of being are privileged in society while others are simultaneously marginalized.

Decolonizing education is a counter-hegemonic framework for contesting colonization, racialization, and forced assimilation strategies, and generates empowerment for Indigenous knowledge systems, health, and well-being through education (Battiste, 1986, 2011). Thus, decolonizing and anti-oppressive education mean much more than the common understanding of promoting cultural diversity and non-Western perspectives. It requires identifying and challenging the root causes of oppression, how inequality is reproduced in the classroom, and finding strategies to counter educational discourses that position Western knowledge as superior and other knowledge (such as Indigenous knowledge) as inferior.

To put it succinctly, Canada has a long history of discrimination that is having a detrimental impact on the health, education, cultures, languages, and economic well-being of Aboriginal peoples (Adelson, 2005; Bourassa, McKay-McNabb, & Hampton, 2004; Kirmayer, Brass, & Tait, 2000; Morrison, Morrison, & Borsa, 2014; Regan, 2010; Truth and Reconciliation Commission, 2015; Wilson & Macdonald, 2010). Prior to colonial contact, Aboriginal peoples had a knowledge system deeply rooted in sustainable relationships with the world around them, which was dynamic and adaptive to the ever-changing landscape, with their knowledge and skills being shared through oral traditions (Battiste, 2013; Michell, 2005; Smith, 2001). Their lives and well-being were severely disrupted upon colonial contact. Colonizers forcefully took the land and, over time, genocide occurred through deliberate starvation, policies which kept Aboriginal peoples from farming, and through disease dissemination (Daschuk, 2013). The implementation of the Indian Act regulated and continues to regulate all aspects of Aboriginal peoples' lives, including their identities, their bodies, and their land (Bourassa, McKay-McNabb, & Hampton, 2004; Carter, 1986). Canada created residential schools in order to force assimilation, resulting in the deaths of an untold number of Aboriginal children, cultural genocide, and the resocialization and acculturation of Aboriginal peoples into White European ways of life (Lowman & Barker, 2015; Miller, 1996; Truth and Reconciliation Commission, 2015). Barman (2012) highlights the policy trajectory over the course of residential school history, explaining that the original premise of residential schools was assimilation, but equality was never imagined. Aboriginal students were kept

from moving beyond Grade 8, with boys learning the lowest trades and farming, and girls learning how to do household chores in preparation for domestic service. Assimilation was only tolerated as long as Aboriginal peoples occupied the lower rungs of Euro-Canadian society.

Clearly this abuse and racism at the institutional, social, political, and educational levels has placed Aboriginal peoples in a perilous position by disconnecting them from their land, livelihoods, languages, families, communities, cultures, and identities. We emphasize that this abuse and racism is not just historical—at the present day there is continued theft of land and resources, broken treaty promises, and the use of violence to regulate Aboriginal bodies (Angus, 2015; Razack, 2002, 2015). Consequently, intergenerational poverty, abuse, and the ongoing colonial project maintain a disparity between Aboriginal and non-Aboriginal peoples in all indicators of well-being, including health and health care, family life, employment, and education (Barnes, Josefowitz, & Cole, 2006; Lavallee & Poole, 2010; Morrison, Morrison, & Borsa, 2014).

The education disparity is further exacerbated in mathematics, a subject that practitioners have produced as neutral (not favouring specific groups), culture-free, and universal (Ernest, 1994; Gerdes, 1996), while also having inherent agency to exclude, create barriers, regulate access to further learning, and prompt discomfort and anxiety in teachers and students (Macmillan, McGregor, & Old, 2005; Popkewitz, 2004; Stinson, 2004). Discussions centred upon anxiety elicited from “math’s complexity and level of difficulty” (Macmillan, McGregor, & Old, 2005, p. 128) distract from the reality that mathematics practitioners are actually the regulatory gatekeepers who are prompting this anxiety. Drawing upon anti-racism and critical race theory, Iseke-Barnes (2000) exposes how mathematics is entwined with colonialism, emphasizing that mathematics is in fact produced in culture. As Bishop (1994) states, “The reality is that Western mathematics developed the value of the universal applicability and validity of its statements. That however does not suggest that this knowledge domain is in any way culture-free, nor value-free” (p.16).

Any North American research that considers mathematics education and achievement disparity of Indigenous peoples needs to be informed by anti-racist and decolonizing education. This involves identifying how race is used in various contexts to name Indigenous peoples as inferior while maintaining that the White culture is the standard of success. Decolonization is one particular anti-racism strategy that looks at challenging

and breaking down the hierarchy of superior and inferior groups produced during colonization. Baker (2006) gives a deeper understanding of how hierarchical racial theories were created by Europeans to justify colonization, and to create perceptions of superiority and inferiority based on presumed physiological differences. Social justice education is another anti-racism strategy that looks at challenging inequality and removing barriers. Without identifying and challenging these barriers as root causes, inequality in the classroom cannot be addressed adequately.

There is sometimes a reluctance for educators and researchers to talk about issues of racialization in education due to the level of discomfort that acknowledgement of White supremacy and dominance engenders for those who benefit. Frankenstein (1990) reports instances in which she received criticism from reviewers who said her inclusion of race, gender, and class issues in social justice mathematics were too controversial. I (Stavrou) have also experienced censorship from the adjudicators of a conference I spoke at about decolonization in mathematics. I was told to avoid words such as “cultural genocide” in regard to colonization because the words were too harsh and might turn the audience off from my talk. Gates and Jorgensen (2009) criticize journal editors for ignoring (or being reluctant to allow publications related to) social justice issues. Discussions of race and oppression are also avoided in some of the literature because many researchers and educators do not see that there is any racial inequality that needs to be addressed (Solomona, Portelli, Daniel, & Campbell, 2005). Tompkins (2002) reports on White teachers’ perspectives on their Mi’kmaw students in a provincial school in Nova Scotia. She observes that the teachers believe the inequality is rooted in Mi’kmaw families and culture, and that it is unrelated to power that they hold as White teachers. Tompkins (2002) explains that the unwillingness or inability to see inequality as an issue of racialization is often achieved through seeing inequality as an issue of meritocracy—the myth that a group’s marginalization is the result of not working hard enough. There are many ways that researchers take up social justice and anti-oppressive education, which is why we defined these ideas in relation to the on-going colonial project, eschewing notions of individual or cultural deficit. In what follows, we consider how some North American researchers and educators take up mathematics education in relation to Indigenous learners.

## Connecting Mathematics, Decolonization, Anti-Oppressive Practices, and Social Justice Education

There is agreement in the literature that Indigenous students are under-represented in mathematics and science-related disciplines and jobs. In Canada, low Aboriginal enrollment and a comparison of achievement levels between Aboriginal and non-Aboriginal students highlighting this disparity is how the story typically begins (Aitken & Head, 2008; Cheek, 1984; Davison, 1992; Ezeife, 2002, 2006, 2011; Graham, 1988; Greer et al., 2009; Macmillan, McGregor, & Old, 2005; Mather, 1997; Powell & Frankenstein, 1997; Saskatchewan Ministry of Education, 2008, 2009, 2010; Scott, 1983). The point of this article is not to reproduce these statistics and arguments, but rather to see what practitioners say are the motivating factors for these disparities in mathematics and education in general.

We will discuss some practitioners who only give passing mention—if at all—to colonization as the foundational cause of disparity in education. For example, Ezeife (2011), discusses how Aboriginal peoples were active practitioners who excelled in mathematics and science prior to Western contact but are now fleeing from mathematics because there is no connection to their cultures: “This feeling of foreignness toward mathematics and science by Aboriginal students leads to a distaste for these fields of study, poor performance in them, with the consequent and foreseeable, if familiar result—under-representation of this group in scientific and technological fields” (p. 43). From this perspective, it is explained that Aboriginal learners avoid mathematics and are disengaged due to a lack of cultural relevance. Rather, we emphasize that Aboriginal learners have additional learning barriers and social disadvantages as a *consequence of colonization and ongoing racism*. A more accurate perspective of the situation is that Aboriginal learners are pushed out of the classroom and excluded from learning mathematics. Attributing the disparity to a lack of cultural relevance does not acknowledge the foundational issues of oppression and racism. A cultural deficit model is reinscribed in Ezeife (2002) who only gives passing mention of colonization, then states that there is a need for mathematics and technology-related specialties in Indigenous communities because

expertise in technological fields would not only help in creating new jobs in aboriginal communities but would also go a long way toward modernizing the

traditional, aboriginal occupations of fishing, hunting, trapping, and arts/design—enterprises that have sustained these communities over centuries, but which now desperately need the injection of newer techniques, tools, and equipment to remain viable. (p. 178)

This discourse around modernization of Indigenous peoples is one of the ways colonization is justified by claiming Indigenous peoples are in dire need of advancement by Western knowledge (Henderson, 2000). Along similar lines, consider Richards and Scott (2009) who report on Canadian data of Aboriginal achievement in mathematics and other school subjects, and suggest in their inadequate discussion of colonization that Aboriginal integration during colonial contact was beneficial since Aboriginal peoples lacked the agricultural “productivity displayed by European economies” (p. 3).

Pewewardy (2002) takes up disparity in education through cultural differences in learning styles. Before he introduces theories on learning styles of American Indigenous students, he talks about the institutional and political practices of assimilation—such as residential schools and the removal of children from their families—as factors contributing to cultural genocide, but then does not integrate this fact into the bigger picture of the present disparity in mathematics. Instead, he talks about mathematics as seldom including connections with “tribal culture” (p. 29), which poses obstacles for mathematics achievement. In terms of cultural styles of learning, Pewewardy (2002) comments that the majority of White children begin school as auditory learners in an oral-instruction environment, which he alleges “places the American Indian/Alaska Native student at a very real disadvantage” (p. 30). This statement is contradictory to the understanding that Indigenous cultures are centred on oral traditions (Kovach, 2010; Michell, 2005). Furthermore, he adds that culturally relevant curricula will connect the student with their heritage and provide the “bridge between his or her world on the reserve, reservation, or in the community” (p. 30) and success in the classroom. The idea that multicultural mathematics provides such obvious success is an oversimplification of mathematics and culture, especially when offered with no justification of how such curricula can be created and why it necessarily closes the achievement gap. Finally, Pewewardy (2002) cites that many American Indigenous students have been taught that time and punctuality are of little importance in the grand scheme of things; therefore, “students may be tardy for class or assignments might be late” (p. 31). Although Pewewardy (2002) writes in his abstract that the differences in

the learning styles is not a cultural deficit, his review seemingly contributes to the hegemonic discourse that produces Indigenous peoples as having a learning style that contributes to their lack of achievement.

Nielsen, Nicol, and Owuor (2008) say that the factors contributing to Aboriginal students' disparity in mathematics is beyond the scope of their article, which is clearly problematic since this removes from consideration the foundational causes of the disparity. They believe Indigenous peoples learning their cultures will provide an entry into deeper self-understanding, and will provide a bridge between mathematics and cultural traditions. Again, we argue this idea is an over-simplification that assumes success in Western mathematics is simply related to students knowing their cultures and being able to relate them to mathematics. We also challenge their framing of Indigenous learners as being unmotivated and unenthusiastic, resulting in "perennial low success and low participation among Aboriginal students in North America" (p. 34).

Brandt and Chernoff (2014) discuss how cultural mathematics is needed to keep students' interest, and that it holds the potential to challenge Eurocentric ideas of learning mathematics. However, they offer no further explanation as to how Eurocentrism is challenged. They go on to say that "by incorporating Aboriginal understanding of numbers and mathematics into the curricula, we should see greater levels of passing rates, and more Aboriginal adults who have high school diplomas and university degrees" (p. 33). Their over-simplified analysis asserts that an "Aboriginal understanding" should translate into higher graduation rates. It is naïve to assume that the education barriers experienced by Aboriginal peoples can be overcome through incorporation of an essentialist view of how they think (or might have once thought), and that the key to graduation and post-secondary education attainment lies in Aboriginal peoples knowing their cultures and applying this knowledge to learning Western ideas. This view reinforces a belief in meritocracy and the misguided notion that Aboriginal peoples can overcome their plight by working harder at understanding themselves. If practitioners believe this understanding is the solution to higher achievement, then Aboriginal peoples will be produced as incapable once again if achievement does not improve, as is likely when systemic issues are not addressed.

In the direction of understanding knowledge systems in Western school subjects, Aikenhead and Huntley (1999) interviewed science teachers in northern Saskatchewan to inquire into how these teachers viewed Western science, how they introduced Aboriginal

knowledge into their science classroom, and how they explained the under-representation of Aboriginals in careers related to science and technology. The authors reported on barriers to accommodating Aboriginal cultures in science classrooms. They found that teachers did not recognize Western science as culturally produced, that teachers believe Aboriginal worldviews are unrelated to learning science, that teachers only included a token amount of traditional Indigenous knowledge in—but not integrated with—school science, and that “students’ disinterest in pursuing science careers was either unexplainable by the interviewees or was blamed on student deficits. Few teachers blamed their curriculum and teaching” (p. 167). Aikenhead and Huntley (1999) reveal that “Aboriginal educators view science as a part of Western ‘progress’ that has oppressed Aboriginal peoples since the time of contact” (p. 169), thus necessitating a decolonizing framework to unpack the ways science and mathematics have been used to contribute to the colonial project. The authors conclude that although the teachers they interviewed were unanimous in rejecting the idea that their science classrooms purposefully assimilated Aboriginal students into a Western worldview, by not treating science as a culturally specific discipline, teachers may be perpetuating unintentional assimilation.

Deer (2013) also reports on similar data related to pre-service teachers’ attitudes on integrating Aboriginal perspectives in Canadian curriculum. He found that some pre-service teachers are apprehensive about this inclusion due to their own lack of Aboriginal cultural knowledge, and the perceived incongruity of Aboriginal cultures with Western education. He also reports on some teachers’ racist attitudes contributing to their unwillingness to consider Aboriginal perspectives in the curriculum.

Macmillan, McGregor, and Old (2005) reported on Aboriginal students’ anxiety in college-level mathematics, and cite that cultural examples in the curriculum enhances interest and motivation in mathematical learning. In their interviews of Aboriginal students, they conclude that the students would feel less anxious if their mathematical learning included aspects of their culture. In contrast, non-Aboriginal students generally believed cultural examples were unnecessary, and that mathematics was “culturally neutral and required sufficient effort and practice” (p. 129). I (Stavrou) have had similar experiences during professional development presentations with non-Aboriginal teachers, who say things like “Math is math, there is no room for culture,” “If I teach special math for Aboriginal students, then I need to do it for my Asian and middle-eastern students,” and “Aboriginal students just need to learn math the same way so that they can graduate, go

on to post-secondary, and be competitive in the job market.” Such ideologies affirm that decolonizing and anti-oppressive education are needed to challenge these assimilative attitudes and expose Western knowledge as a socially constructed system that normalizes cognitive imperialism, racism, and the marginalization of other knowledge systems (Battiste, 1986, 2011, 2013). Applying decolonizing strategies to mathematics will make visible that it is a subject developed in time and place, and will expose the imperialistic operation that deprives mathematics of its historical roots and human construction.

We take issue with asking Indigenous peoples to remember and recall histories and traditions from which they have been forced to disassociate. Many Indigenous peoples have internalized racism, self-hatred, and shame toward their culture (Young et al., 2015). In the wake of the destruction wrought by Canadian residential schools, the current valorization of Aboriginal cultures has generated cultural fundamentalism and issues of cultural authenticity and cultural hierarchy within Aboriginal communities based on who can claim to be a “real Indian” by exhibiting competency in Aboriginal language and culture (St. Denis, 2004, 2007). Although residential schools violently forced Aboriginal peoples to forsake and forget their languages, cultures, and identities, educationalists now want Aboriginal peoples to recall and share their cultures and traditions for the purpose of multiculturalism in the classroom and what they presume will lead to Aboriginal success in “hard” subjects. For example, Pewewardy (2002) says that students should learn mathematics terminology in their Native language and then relate this knowledge to the English-language mathematics vocabulary, since this “teaches students lessons about the diversity among American Indian/Alaska Native cultures” (p. 29). Yet, as St. Denis (2004) explains, Aboriginal students and teachers feel shame and inadequacy when they cannot share their languages and cultures in authoritative and authentic ways.

St. Denis (2007) also reports that Aboriginal peoples are described as being reckless and irresponsible for losing their cultures, as opposed to the acknowledgement that their languages were “slayed” (p. 43) and their cultures subject to destruction through violence, legislation, and policy decisions, as well as shaming. Indeed, consider this example: Barta et al. (2001) investigate ways the Shoshoni peoples in the United States traditionally used and spoke of mathematics within their culture. The authors explain that traditional Shoshoni culture is most frequently practised by the senior members of their current communities, and that “while educational and cultural efforts are being made to preserve the culture and its traditional ways, it appears that memories and practices of old

ways is slowly being lost” (p. 2). In other words, despite Western help, they are forgetting their language and culture. We argue that discussing cognitive imperialism and the historical and ongoing marginalization of Indigenous knowledge (Battiste, 1986, 2011) would serve to explain why the Shoshoni culture is slowly being erased—not the more innocuous sounding “lost.” Barta et al. (2001) hope that unearthing traditional uses of Shoshoni mathematics could be used by school teachers to develop culturally relevant curriculum because “Shoshoni children may not know their people count if they are not taught this now obvious fact” (p. 33). By that statement, we argue that the authors are revealing what they believe is significant to the Shoshoni culture through identifying ways Western mathematics were used. While we acknowledge the significance of these authors revitalizing cultural artifacts and language, their comment on the rigour of mathematics in Shoshoni culture is made through a Western lens. For example, they refer to the verbal naming of numbers as “mathematically rich” (p. 15), because of the way it closely approximates the base 10 number system of Western mathematics.

Our contention is that without decolonizing discourses, the framing and revitalization of Indigenous cultures is contrasted against Western standards of knowledge, and consequently could be taken up as archaic and inferior if it does not approximate Western mathematics adequately. The authors also describe, for example, a teepee ring as a “function of the length of the poles used to construct it and the number of hides used to make the covering” (p. 19). The authors are talking about functional relationships—ideas from Western mathematics—which is imposing an assumption about the ways Shoshoni people saw their practice of constructing teepees. As Iseke-Barnes (2000) clarifies, “Aboriginal cultures did not use mathematics in a Western way: that is to say, they did not quantify, specify relationships, locate themselves or use shapes for designs in the same way that Europeans traditionally have” (p. 141). In general, researchers need to realize that Indigenous knowledge cannot be scientifically categorized (Battiste, 2002), and should avoid the belief that Indigenous knowledge can be compared to Western science and mathematics and that multicultural education should be built around these contrived comparisons.

We also challenge the way some North American practitioners take up the meaning of multiculturalism in mathematics learning. In many cases, incorporating multicultural content is meant to satisfy mandates of providing alternative perspectives. In separate studies, Lunney Borden (2013) and Deer (2013) point out that some practitioners treat Indigenous knowledge of mathematics as an add-on to the mainstream curricula. In

our experiences, school teachers often want concrete examples of Aboriginal content in mathematics—which then gets incongruently and awkwardly placed—so that they can say they have shared an alternative perspective with students. For instance, teaching geometry by showing a medicine wheel as an example of a circle, a drum as a cylinder, and a tipi as a cone are superficial add-ons that do little in providing deeper understanding of mathematics or Aboriginal cultures. Doolittle (2006) argues that these add-ons lead to an oversimplification of complex ideas, trivialize Indigenous knowledge, and generally do not address the learning needs of students.

This concern is echoed by Sleeter (1997) who argues that multicultural elements have not resulted in higher mathematics achievement for students and do little to address their learning needs. The quest for authentic Aboriginal identity in curricula is currently a high priority, according to St. Denis (2004). These superficial pedagogical examples, which are intended to acknowledge multiculturalism, may serve to affirm instructor goodness but do nothing to address the fundamental problem of inequality. I (Stavrou) have also witnessed discussions on integrating Aboriginal content in the Saskatchewan K–12 mathematics curriculum, during which it was suggested by one of the committee members that a good classroom activity would be to have all students (including non-Aboriginal) learn statistical concepts by doing quantitative research on low Aboriginal graduation rates, or to explore Aboriginal obesity/diabetes rates. In those examples, mathematics is used in a harmful way to decontextualize and reduce complex social issues to statistical data. To move toward social justice, these concepts would need to include decolonizing and anti-oppressive considerations so that they are working toward a solution, rather than reinscribing deficit-oriented approach.

As we mentioned earlier, there are certainly many North American researchers and educators who make meaningful connections between mathematics and Indigenous knowledge. Consider Lunney Borden (2013) who applies decolonizing methodology in her work, acknowledging how research is a contentious issue for Aboriginal peoples because of its connection with colonization and imperialism. Her work is part of a larger decolonizing mathematics education project in a Mi'kmaw community located in Nova Scotia that looks at how the students understand mathematics through the Mi'kmaw language. Her work considers differences in how mathematical concepts are structured in Mi'kmaw, and how learning mathematics as it occurs naturally through this language supports the learning of values and ethics—topics excluded from Western mathematics.

It is imperative to understand that her work is drawn from relational research situated in community. In the context of her work, discussions open with “Is there a word for...?” showing how learning the Mi’kmaq language learning and mathematics support each other. However, without meaningful social contexts and the necessary relational work at the foundation, researchers attempting similar work might reproduce feelings of inferiority by people who are unable to share their languages. There is also the obvious (though often overlooked) issue that translations back and forth simply do not exist—which should not be taken as a cultural shortcoming. I (Stavrou) have worked with Cree educators in Saskatchewan who describe their frustration in being asked to find translations of Western mathematical terms in their language. They all describe feeling frustrated and inadequate that they have to constantly justify why their Cree knowledge does not include Western mathematical translations. Donald, Glanfield, and Sterenberg (2011) articulate the feelings of inferiority perpetuated through interactions between so-called content professionals who claim to have the way to success for Aboriginal communities. The implementation of strategies and so-called best practices in Aboriginal communities creates a system in which Aboriginal peoples are deemed unable to tap into their rich history and social resources without instructions from “outside experts.”

Research centred on cultural place-based activities, such as the one described by Rickard (2005) in which Alaskan students design fish racks to study area and perimeter, is another example where a meaningful connection is attempted. His work is part of a larger series of modules that are meant to supplement a K–6 mathematics curriculum by supporting the Yup’ik Alaskan culture. Like Lunney Borden (2013), Rickard’s work (2005) is co-composed within a community over an extended time with relational understandings, and does not attempt to represent a pan-Indian identity, or the idea that the activities, knowledges, and languages in local contexts can be extracted and generalized, categorized, and disseminated as some kind of standard Indigenous identity. Generalizations become stereotypes that romanticize the “traditional Indian”—an icon with which many Indigenous peoples do not identify (Friedel, 2011), as they are linguistically and culturally diverse with varied degrees of connection to their traditional heritage. Thus, it is important that educators understand that the research and teaching that is developed in a meaningful way comes from Indigenous methodologies of connecting to place, context, and working in relation (Lunney Borden & Wiseman, 2016).

There is a need for an Indigenous and non-Indigenous coalition in the understanding of identities and the processes of racialization that continue to affect Indigenous peoples. In a Canadian context, St. Denis (2007) describes the issues surrounding Aboriginal and settler identities, and believes that engaging in critical race analysis would provide a deeper understanding. She suggests this understanding comes from locating colonization and its ongoing processes as the root causes of identity conflicts and inequality, and she shows that cultural revitalization efforts can have contradictory effects, including perpetuating limited notions of the “real Indian” (p. 1070). We apply her analysis to mathematics education in North America, and the efforts to connect mathematics to essentialist notions of authentic Indigenous identity. We believe that if researchers and educators acknowledge the root causes of inequality, then there would be a shift in the literature away from positing a lack of cultural relevance as the reason that Indigenous students are disengaged with mathematics. Such a conceptualization of the problem leads to the imposition of predominantly Western expert versions of multicultural curricula. A sole focus on cultural revitalization and a celebratory cultural relevance keeps the gaze away from the effects of racism. In Canada, Aboriginal peoples are often viewed through a multicultural lens as just one of the many cultures that make up the mosaic with no particular status or rights stemming from being original inhabitants (St. Denis, 2011). Such views steer away from solutions based in the sovereignty and protection of land, and dismantling the systems of power that perpetuate economic, social, and political inequality for Aboriginal peoples.

## Conclusion

We critique what is taken up by practitioners as a framework for more inclusive teaching and learning practices for Indigenous peoples in North America. We highlight the misidentification of the causes of disparity in mathematics achievement and literacy, and the miscalculations that result in attempting to find remedies. We emphasize that practitioners require a decolonizing and anti-oppressive discourse to address social justice issues in mathematics education effectively. We begin by describing decolonizing, anti-oppressive, and social justice education to provide a framework for the discussion of the current inadequacies in mathematics education. How a problem is framed invites or limits solution and possibility. We acknowledge that there is contention and confusion with

regards to decolonizing and social justice education, and how solutions to inequality are imagined. With this in mind, we point to ongoing colonization and racism as the reasons for structural inequality, and emphasize that in North America an anti-oppressive framework is needed to realize productive solutions to Indigenous students' lower achievement in mathematics. While there are many North American researchers and educators whose work is informed by decolonizing and anti-oppressive education, we identified cases in which these ideas are lacking or misinterpreted, resulting in remedial efforts that are insufficient to solve the problem. Indigenous students' lower achievement is attributed to a lack of cultural relevance in the teaching of mathematics, and Indigenous learners are portrayed as disengaged with a subject that is depicted as somehow making itself deliberately hard to learn. There is a push for cultural revitalization in the classroom, without acknowledging—or only giving passing mention to—the fact that Indigenous peoples were alienated from their cultures.

Authentic Indigenous activities are a desired commodity in the search for a means to engage Indigenous students, but are often incorporated in a decontextualized and superficial way. This approach does little to address inequality, and instead perpetuates stereotypes and imposes romanticized identities based in Western notions of the traditional Indian. Further, the curricular commodification of Indigenous cultures makes Indigenous peoples feel inadequate when they cannot perform their culture or language. We believe with St. Denis (2007) that an anti-racist, anti-oppressive analysis can help educators understand the effects of ongoing colonialism, the limits of cultural revitalization and multiculturalism, and point to more effective measures in addressing educational inequality.

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