Indigenous Perspectives in School Mathematics: From Intellect to Wisdom*

Glen Aikenhead

Abstract

When some Indigenous mathematizing is taught in school mathematics, something important and strange occurs. Not only does the achievement of Indigenous students dramatically increase, but the achievement of non-Indigenous students goes up on average as well. A clash between most Indigenous students' worldviews and the worldview endemic to mathematics tends to be an obstacle for these students. For example, one fundamental epistemic difference between the Eurocentric worldview of mathematics and the Indigenous worldviews of mathematizing concerns what type of understanding is expected. On the one hand, conventional school mathematics deals with an *intellectual* tradition of understanding—only thinking with the content. And on the other hand, Indigenous mathematizing deals with a *wisdom* tradition of understanding—thinking, doing, living, and being with the content. Indigenous mathematizing is obviously richer. This worldview clash also exists but to a lesser degree for a majority of non-Indigenous students. Different worldviews reflect differences between cultures; in this case, between a student's culture and the culture of mathematics. This research finding contradicts the Platonist belief that school mathematics is culture-free, value-free, universal, decontextualized, and purely objective; a challenging obstacle for many students' success, especially for Indigenous students. Upon analysis, however, the Platonist belief turns out to be a deception, historically perpetrated in the nineteenth century when public education was being established. In Canada's era of reconciliation with Indigenous peoples, it seems most appropriate to correct the detrimental deception and revamp the nineteenth century mathematics curriculum into a twenty-first century evidence-based pragmatic curriculum.

Introduction

This chapter acknowledges school mathematics' 200 years of hegemony and highlights its hidden cultural nature. In the nineteenth century, academics and governments independently created two major obstacles that have severely depressed Indigenous students' high school graduation rates. First, academic educators defined school mathematics as being decontextualized, value-free, non-ideological, purely objective in its use, and universal in the sense of being the only legitimate way of mathematizing. Secondly, the Canadian Federal Government established Indigenous residential schools. Today in the twenty-first century, mathematics educators know how to mitigate the consequences of both obstacles, yet the secondary curriculum by and large carries on its nineteenth century function.

The Rise of Platonist School Mathematics

The nineteenth century definition of school mathematics has a historical context. What we call "mathematics" today evolved over the ages in various civilizations, from which early European mathematicians appropriated what made sense to them (Ernest 2016b). A mechanism for this appropriation, based on language-laden cognition (Kawasaki 2002), describes how a concept can have worldview presuppositions implicitly attached to it.

For example, the concept of circle in school mathematics has a cluster of Eurocentric peripheral concepts such as point and plane, as well as associated peripheral values such as intellectual purity, consistency, and objectivity. If a mathematics textbook stated, "Indigenous medicine wheels have circle properties," then the phrase "circle properties" refers to a decontextualized meaning of the term "circle" with its cluster of peripheral Eurocentric concepts. The textbook author has not understood, or has purposefully ignored, the contextualized subjective, holistic and spiritual peripheral concepts connected to an Indigenous meaning of circle.

Culture-based peripheral concepts get lost in translation. Thus, imagine the challenge for Indigenous speaking students when they unknowingly bring their unconscious peripheral concepts into their mathematics class that pretends to have none. Similarly, imagine the implicit ideas that were lost in translation when early European mathematicians appropriated concepts from ancient Egyptian, Hindu, Arabic and Chinese cultures (Aikenhead 2017a, section 4.4). This appropriation unconsciously stripped away ancient peripheral concepts, and unconsciously replaced them with European peripheral concepts associated with the culture of European mathematicians.

The European renaissance version of mathematics slowly found a home in elite British universities during seventeenth to eighteenth century England. In this Age of Enlightenment, mathematics had to compete for a place in Cambridge's & Oxford's stringent curricula comprised of ancient languages, religious studies, history, and the classics. A curriculum's

---

*Aikenhead, G. S. (2018). Indigenous perspectives in school mathematics: From intellect to wisdom. In A. Kajander, J. Holm, & E. J. Chernoff, (Eds.) (2018), *Teaching and learning secondary school mathematics: Canadian perspectives in an international context* (pp. 39-50). Cham, Switzerland: Springer International Publishing AG. https://doi.org/10.1007/978-3-319-92390-1.

The European renaissance version of mathematics slowly found a home in elite British universities during seventeenth to eighteenth century England. In this Age of Enlightenment, mathematics had to compete for a place in Cambridge's and Oxford's stringent curricula comprised of ancient languages, religious studies, history, and the classics. A curriculum's difficulty was thought to prepare the mind for any future event, occupation, or profession (Willoughby 1967). Decontextualized abstractions ensured difficult content. Channelling Plato's dichotomy "World of Ideas" versus "Phenomenal World" (Kawasaki 2002, p. 25), mathematics instructors divorced their ethereal abstract subject matter from the context of worldly events. This explains their "Platonist" moniker.

A Platonist belief about mathematics assumes "a static but unified body of certain knowledge. Mathematics is discovered, not invented" (Ernest 1988, website quote). This belief promotes a "doctrine that mathematical entities have real existence and that mathematical truth is independent of human thought" (Collins English Dictionary 1994). An acultural, decontextualized, value-free, non-ideological, objective school subject flourished in the competition for a place in the British elite Latin Grammar Schools, which began to teach mathematics as prerequisites for entrance to elite universities (Willoughby 1967).

The Industrial Revolution (eighteenth to nineteenth centuries) led to the establishment of the British public education system, quickly adopted in Canada. Mathematics became a core subject at a time when tensions escalated between two opposing philosophies of public education: academic elite versus practical relevance (Layton 1981) that would contextualize Platonist mathematics content in the everyday world actually experienced by students and adult citizens employed in, for example, business, manufacturing, bureaucratic and professional occupations. Married to an absolutist philosophy, the Platonists defended their territory by eschewing practical utility and marginalizing mathematics' human features, such as its values and ideologies, plus its roles in everyday life. This stance was taken even though Platonists' knowledge could be identified with such values as generalizability and such ideologies as quantification (Corrigan et al. 2004). Ernest (1991) described what happened: "[T]he values of the absolutists [were] smuggled into mathematics, either consciously or unconsciously, through the definition of the field" (p. 259). In the end, Platonist's elitism won the battle over practical relevance.

What clever smuggling strategy did Platonists use to define school mathematics? First, they drew on a binary, "logical versus irrational," invented by "Western culture dating back to Socrates, Plato, and Aristotle" (Hall 1976, p. 213), in order to construct their own theoretical binary: "*formal mathematical discourse*" versus "*informal mathematical discourse*" (Ernest 1991, pp. 259–260). Then they arbitrarily assigned the highly abstract decontextualized aspects of mathematics to the *formal discourse* category, which would be their discipline of school mathematics. This assignment was consistent with the ancient Greek philosophy proclaiming mathematics content is to be *discovered* as abstract objects that constitute the universe, rather than being invented by humans (Aikenhead 2017a, b).

The *informal discourse* category comprised everything that would have made school mathematics a human endeavour; for example, the application of Platonist mathematics in political-societal-economic contexts (Skovsmose 2016); its presuppositions, ideologies, and values by which it operates; its history; and its preferences that guide mathematicians. Informal mathematical discourse was suppressed so effectively that most mathematics educators seem unaware of it today. Ernest (1991) characterized the Platonist's strategy as illusionary: "[A]t the heart of the absolutist neutral view of mathematics is a set of values and a cultural perspective, as well as an ideology which renders them invisible" (p. 260). In 1921, Einstein had proposed a parallel explanation, described in Aikenhead (2017a, section 4.2.1). Simply put: a surreal version of mathematizing became institutionalized; a humanistic version was suppressed.

Political-social-economic power, rather than evidence-based practice, has successfully maintained the Platonist dogma until recently for three reasons: it provides school mathematics with the highest status among school subjects; it allows other institutions to use students' success at mathematics as an unquestioned objective screening device for post-secondary education and for employers, whether or not student assessment is objective and whether or not the high school mathematics content relates to the post-secondary program or the occupation; and it guarantees that "prestige, control, authority, and power are gained by the knower" (Russell 2016, p. 75). Russell and Chernoff (2013) described this social screening function as "unethical" (p. 109).

The Platonist ideology of quantification demands that outcomes of schooling be commodified so that achievement can be assessed numerically (Ernest 2016a). This quantified worth of students, teachers, and educational jurisdictions is so simplistic it immeasurably distorts reality (Aikenhead 2017a, section 9.4). Quantification conveys a false aura of objectivity (Aikenhead 2008). Simply put, political expediency trumps quality education defined as "the human dimensions of knowing" (Ernest 2016a, p. 53). Even worse, the allocation of a government's "resources for testing is the main argument to justify math contents" in curricula (D'Ambrosio 2016, p. 33).

The Rise of Cultural School Mathematics

The Platonist belief was challenged when anthropologists discovered that in all cultures mathematical systems developed in tandem with people's everyday cultural activities (Wilder 1981). Bishop's (1988) research identified six fundamental types of mathematizing found in most major cultures: counting, locating, measuring, designing, playing, and explaining. "Mathematics, as an example of a cultural phenomenon, has a 'technological' component" (p. 146). Bishop characterized mathematics as *a symbolic technology for building a relationship between humans and their social and physical environments*.

Cultural practices are based on a group's collective worldview. A *clash* between most Indigenous students' worldviews and the worldview endemic to Platonist school mathematics tends to make mathematics foreign to many students (Aikenhead 2017, section 3.3). The clash, for example, could be due to an epistemic dissonance caused by different expectations of learners. Conventional school mathematics expects an *intellectual* understanding by students—thinking with the content largely in analytical-deductive ways.

On the other hand, Indigenous mathematizing expects a *wisdom* understanding—thinking, doing, living, and being with a mathematizing process in a holistic way (Aikenhead and Michell 2011). To Indigenous students, their culture's mathematizing seems richer and makes common sense. Differences in expectations between an intellectual and wisdom tradition of understanding creates degrees of alienation and marginalization for most, but not all, Indigenous students entering mathematics classrooms. This worldview-based clash also exists to varying degrees for many non-Indigenous students (Aikenhead 2017, section 9.3; Nasir et al. 2008), depending on how closely a student's worldview harmonizes with a Platonist-like worldview.

Different worldviews explain differences between cultures; such as between an Indigenous student's home culture and the culture of school mathematics with its Western or Euro-American cultural features (Aikenhead 2017; Ernest 1988; Russell and Chernoff 2013). These features include, for example, an epistemology of consistency, an ontology that embraces Cartesian duality, and an axiology of objectivity; as well as Skovsmose's (2016) mathematics in action.

Ernest (1988) replaced a Platonist belief with a cultural belief by hybridizing the formal and informal discourse dichotomy into one category, a *Euro-American school mathematics* (Aikenhead 2017, section 4.2). He characterized mathematics "as a dynamically organized structure, located in a social and cultural context" for problem solving; and a "continually expanding field of human creation and invention" (as cited in Aikenhead 2017, p. 26).

The Political-Social Context of Reconciliation

The crucial importance of diminishing Indigenous students' cultural clashes with Platonist school mathematics becomes evident in Canada's twenty-first century era of reconciliation, which emerged in direct response to Indigenous people having endured colonial genocide (Woolford et al. 2014). Colonial genocide took the form of marginalization, violence, engineered starvation, cultural erosion, and unrelenting racism (Daschuk 2013). It continues today as neo-colonialism causing Indigenous people to suffer degrees of deprivation in education, social assistance, housing, health care, employment, and criminal justice. This is the context of teaching mathematics in today's Canadian classrooms that include Indigenous students.

One example of neo-colonialism is hearing a mathematics teacher complain, "The [Indigenous] students who come to our school have serious gaps in their education" (FNESC 2011, p. 29). By framing the issue as a lack of background knowledge, teachers implicitly fault the students. What actually happened, however, is Canada's colonization forced an "educational debt" on Indigenous students and their families (Bang and Medin 2010, p. 1023). It is this debt that the teacher is actually complaining about; a debt not caused by students. Teachers are expected to help pay it off through teaching mathematics in an anti-discriminatory way, such as teaching according to a cultural understanding of the subject, which contextualizes mathematics in both Canadian mainstream culture and local Indigenous cultures. The quoted teacher's deficit model of teaching disregarded the asset model: "being open and accepting of students' worldviews and experiences … teachers can tap into the holistic and experiential resources of students and treat these resources as assets for academic success" (Aikenhead and Michell 2011, p. 142). What began as a teacher's "objective" assessment of Indigenous students' background knowledge has turned out to be an ethical judgement over a teacher's responsibilities towards Indigenous students. Similarly, what is considered to be an objective screening process of high school students becomes a discriminatory act against one of the three founding nations of Canada; the one that originally taught the other two how to survive. Such discrimination is systemic racism to be sure (Alberta Education 2006).

What went unnoticed by the complaining teacher is the fact that the Platonist strategy to define a mathematics curriculum solely as formal mathematics discourse and to suppress its informal discourse, seriously increased the culture clash for Indigenous students; thus lowering graduation rates. A Platonist curriculum and Canadian residential schools have similar effects on high school graduation rates; albeit different degrees of racism, but systemic racism nonetheless.

Residential schools were a centre piece of colonial genocide: kidnapping children for long periods of time (TRC 2016). The Federal Government's policy to kill the Indian and save the child was severely enacted by church-run schools, from about 1834–1996. Thousands died. Those who did survive to reach high school were usually offered manual labour type of courses: a decision that prevented students from graduating from high school.

Taking responsibility to alter a deficit teaching approach to an asset approach is one way for educators to engage in reconciliation (TRC 2016). Another way is for a Ministry of Education to transform a nineteenth century Platonist curriculum into a twenty-first century curriculum based on a cultural belief about school mathematics. The transformation amounts to a shift from a narrow intellectual understanding to a broader wisdom understanding of school mathematics as cultural practices.

Implications of a Culture-Based Mathematics

Since the 1980s, research and development (R&D) projects have successfully explored ways to mitigate culture clashes between Indigenous students' home culture and the culture of Platonist curricula and conventional classrooms. Two types of R&D programs are generally evident in the literature: those drawing upon Indigenous mathematizing (e.g., ethnomathematics), and those being fully cross-cultural (illustrated below). Aikenhead (2017, section 8) describes and critiques 10 such projects, most of which represent the first type of R&D project.

The first type investigates, on occasion, Platonist school content contextualized in some Indigenous mathematizing. When this type of instruction takes place, something unexpected occurs consistently. Not only do Indigenous students' mathematics scores rise dramatically (e.g., Lipka and Adams 2004; U.S. Congress HRSECESE 2008), but non-Indigenous students' average achievement increases noticeably (e.g., Furuto 2014; Nelson-Barber and Lipka 2008; Richards et al. 2008; Rickard 2005). Such research studies expose serious shortcomings in conventional school mathematics. Where are the research studies supporting Platonist mathematics? Is tradition a legitimate rationale, in light of this evidence-based practice?

Teaching materials must be developed to support teachers. This is accomplished within a framework of respect by collaborating with Indigenous Elders, knowledge holders, teachers, and community members; illustrated by Aikenhead (2017, sections 6.1 & 8). Indigenous artifacts or processes are usually chosen so that mathematics educators can superimpose a Platonist concept or image onto the artifact or process, and then teach it in a mathematics lesson. A detailed language-laden cognitive model for this transformation is explained by Aikenhead (2017, sections 4.4 & 6.3) in terms of a sequence of steps: superimposition, deconstruction and reconstruction. Student interest and engagement is heightened by using concrete Indigenous examples in mathematics classes. But some significant culture clashes still remain (Aikenhead 2017, section 9.3). A more extensive transformation of school mathematics is required.

The second type of R&D project adds to the first type by changing Platonist school mathematics into culture-based school mathematics—Euro-American school mathematics. Curriculum content is drawn from mainstream Canadian cultural artifacts and processes having an analogic meaning in Platonist mathematics. In this context the Platonist content is taught to students. Some innovative teachers already do this to some extent. But there is more to add.

Some mathematics lessons need to include what Platonists once concealed: informal mathematical discourse; that is, certain ideologies, values, and presuppositions embedded in the culture of Euro-American mathematics and how it is used in political-social contexts (Aikenhead 2017, sections 4.2.1 & 4.5; Skovsmose 2016). On an age-appropriate basis, teachers will make explicit this cultural nature of Platonist mathematics. Some peripheral concepts will be selected from a triad of sources: Platonist mathematics, mainstream society, and Indigenous mathematizing.

In short, Euro-American mathematics differs from, but coexists with, other culture-based mathematical knowledge systems (Bishop 1988). This means that "*cross-cultural* Euro-American mathematics" (Aikenhead 2017, p. 42, emphasis added) will be an amalgam of formal (Platonist) and informal (cultural) mathematical discourses, plus the intermittent inclusion, to a non-tokenistic extent, of Indigenous mathematizing (the first type of R&D project). This combination effectively diminishes most culture clashes between Indigenous students' cultural self-identities and the culture of school mathematics—Euro-American mathematics. The triad combination (listed just above) illustrates that different cultures have unique ways of inventing a symbolic technology in order to build a relationship between people and their political, social, economic and physical environments.

At the same time, a twenty-first century curriculum needs to be purged of non-essential Platonist content (Aikenhead 2017, sections 2.4 & 10.2). "Most secondary students" experience degrees of dissonance with the worldview endemic to a Platonist belief (Aikenhead and Elliott 2010, pp. 334–335). Mukhopadhyay and Greer (2012) challenge the "supremacist position maintained by many mathematician educators who regard abstract mathematics as the crowning achievement of the human intellect, and school mathematics as the transmission of its products" (p. 860). Criteria for choosing curriculum content must focus on "crucial concepts" (Jorgensen 2016) that answer the perennial questions, "Why do we need to know this?", "When will I ever use this?" Political promises about a nation's competitive edge in globalized markets, or about strengthening students' critical thinking, do not stand up to scrutiny (Aikenhead 2017).

For the "24 percent" of high school students living in OECD (Organisation for Economic Co-operation and Development) countries who anticipate a future in a science-related occupation (OECD 2016, p. 113), a highly challenging pre-professional, pre-calculus, culture-based pathway can be designed with a greater emphasis on *need-to-know* Platonist content, compared to a full culture-based mathematics curriculum for the 76% majority of students. A one-size-fits-all conventional curriculum does not represent twenty-first century realities (Russell 2016). Most students respond by "playing Fatima's rules" (Aikenhead 2006, p. 28) to make it appear as if meaningful learning has occurred, when it has not; only credentials have been acquired.

Implications for Teachers

Cross-cultural school mathematics involves modifying instruction. In the spirit of reconciliation, teachers and students will move back and forth between the *culture* of Euro-American school mathematics (i.e., the amalgam of Platonist content and its cultural features that include its actions in society) and the *culture* of a local Indigenous community; with an emphasis on the former. Cross-cultural Euro-American mathematics is implemented within a culturally responsive or place-based pedagogy (Aikenhead et al. 2014; Michell et al. 2008, respectively). Teachers cannot effectively begin, however, without experiencing a cultural immersion (at least 2 days to begin with) designed and run by Indigenous Elders and/or knowledge holders (Aikenhead et al. 2014). Academic workshops are simply ineffective.

Professional development must also include readings about the twenty-first century cultural understanding of the nature of mathematics, followed by self-reflection and discussions within teacher networks; all dedicated to reversing the nineteenth century Platonist indoctrination of students, teachers, and the general public. In some cases, strategies used in cult deprogramming should not be ignored because some teachers' professional identities and belief systems are being challenged. Patient, supportive, ego-centred approaches are needed. This takes time.

Teachers' transformation is a life-long journey along a path of reconciliation. The journey should begin with small innovations, and progress should be measured in years, not months. Progress is accelerated when teachers are mindful of students' diverse recurrent learning strengths (Aikenhead et al. 2014). Examples include: visual more than verbal, oral more than written, and reflective more than trial-and-error. An acquaintance with features of the local Indigenous language is equally beneficial (Aikenhead 2017, section 6.4).

Conclusion

"There are powerful forces at work keeping cultural domination and institutional racism in place, for it serves the interests of capital and the politically powerful" (Ernest 1991, p. 268). By suppressing the cultural nature of school mathematics, and by dismissing Indigenous mathematizing as irrelevant, a Platonist belief about school mathematics works against any agenda to decolonize its curriculum. A Platonist form of racism is simply anti-reconciliation.

Because the composition of today's high school mathematics was mainly established by a narrow nineteenth century definition of the subject, it is reasonable to redefine the subject today in an evidence-based, inclusive, transparent way; and in terms of a twenty-first century cultural understanding of Euro-American mathematics. This redefinition will renew a mathematics curriculum from only offering *intellectual* understandings, to promoting *wisdom* understandings.

Many Indigenous students respond positively to cross-cultural, Euro-American school mathematics, judged by their dramatically increased achievement. Most non-Indigenous students' achievement profits as well. The result is a win-win situation for all students.

References

Aikenhead, G. S. (2006). *Science education for everyday life: Evidence-based practice*. New York: Teachers College Press.

Aikenhead, G. S. (2008). Objectivity: The opiate of the academic? *Cultural Studies of Science Education, 3*, 581–585.

Aikenhead, G. (2017). *School mathematics for reconciliation: From a 19th to a 21st century curriculum*. Retrieved from https://www.usask.ca/education/documents/profiles/aikenhead/index.htm

Aikenhead, G. S., & Elliott, D. (2010). An emerging decolonizing science education in Canada. *Canadian Journal of Science, Mathematics and Technology Education, 10*, 321–338.

Aikenhead, G., & Michell, H. (2011). *Bridging cultures: Indigenous and scientific ways of knowing nature*. Toronto: Pearson Education Canada.

Aikenhead, G., Brokofsky, J., Bodnar, T., Clark, C.,... Strange, G. (2014). *Enhancing school science with Indigenous knowledge: What we know from teachers and research*.

Saskatoon: Saskatoon Public School Division. Retrieved from http://www.amazon.ca/Enhancing-School-Science-Indigenous-Knowledge/dp/149957343X

Alberta Education. (2006). *Common curriculum framework for K-9 mathematics: Western and Northern Canadian protocol*. Edmonton: Author.

Bang, M., & Medin, D. (2010). Cultural processes in science education: Supporting the navigation of multiple epistemologies. *Science Education, 94*, 1009–1026.

Bishop, A. J. (1988). The interactions of mathematics education with culture. *Cultural Dynamics, 1*(2), 145–157. *Collins English dictionary*. (1994). Glasgow: HarperCollins Publishers.

Corrigan, D., Gunstone, R., Bishop, A., & Clarke, B. (2004, July). *Values in science and mathematics education: Similarities, differences and teacher views*. A paper presented at the 35th annual meeting of the Austalasian Science Education Research Association, Armidale, NSW, Australia.

D'Ambrosio, U. (2016). Ethnomathematics: A response to the changing role of mathematics in society. In P. Ernest, B. Sriraman, & N. Ernest (Eds.), *Critical mathematics education: Theory, praxis and reality* (pp. 23–34). Charlotte: Information Age Publishing.

Daschuk, J. (2013). *Clearing the plains: Disease, politics of starvation, and the loss of aboriginal life*. Regina: University of Regina Press.

Ernest, P. (1988). *The impact of beliefs on the teaching of mathematics*. Retrieved from http://webdoc.sub.gwdg.de/edoc/e/pome/impact.htm

Ernest, P. (1991). *The philosophy of mathematics education.* London: Routledge-Falmer. Retrieved from https://p4mriunpat.files.wordpress.com/2011/10/the-philosophy-of-mathematics-education-studies-in-mathematicseducation.pdf

Ernest, P. (2016a). Mathematics education ideologies and globalization. In P. Ernest, B. Sriraman, & N. Ernest (Eds.), *Critical mathematics education: Theory, praxis and reality* (pp. 35–79). Charlotte: Information Age Publishing.

Ernest, P. (2016b). The problem of certainty in mathematics. *Educational Studies in Mathematics, 92*, 379–393.

First Nations Education Steering Committee (FNESC). (2011). *Teaching mathematics in a First Peoples context: Grades 8 and 9*. Vancouver: Author. Retrieved from http://www.fnesc.ca/wordpress/wp-content/uploads/2015/05/PUB-LFP-Math-First-Peoples-8-9-for-Web.pdf

Furuto, H. L. (2014). Pacific ethnomathematics: Pedagogy and practices in mathematics education. *Teaching Mathematics and Its Applications, 33*, 110–121.

Hall, E. T. (1976). *Beyond culture*. Toronto: Doubleday.

Jorgensen, R. (2016). The elephant in the room: Equity, social class, and mathematics. In P. Ernest, B. Sriraman, & N. Ernest (Eds.), *Critical mathematics education: Theory, praxis and reality* (pp. 127–145). Charlotte: Information Age Publishing.

Kawasaki, K. (2002). A cross-cultural comparison of English and Japanese linguistic assumptions influencing pupils' learning of science. *Canadian and International Education, 31*(1), 19–51.

Layton, D. (1981). The schooling of science in England, 1854–1939. In R. MacLeod & P. Collins (Eds.), *The parliament of science* (pp. 188–210). Northwood: Science Reviews.

Lipka, J., & Adams, B. (2004). *Culturally based math education as a way to improve Alaska Native students' math performance* (Working paper no. 20). Athens: Appalachian Center for Learning, Assessment, and Instruction in Mathematics.

Michell, H, Vizina, Y, Augustus, C., & Sawyer, J. (2008). *Learning Indigenous science from place*. Retrieved from http://iportal.usask.ca/docs/Learningindigenousscience.pdf

Mukhopadhyay, S., & Greer, G. (2012). Ethnomathematics. In J. A. Banks (Ed.), *Encyclopedia of diversity in education* (pp. 857–861). Thousand Oaks: SAGE Publication.

Nasir, N. S., Hand, V., & Taylor, E. V. (2008). Culture and mathematics in school: Boundaries between "cultural" and "domain" knowledge in the mathematics classroom and beyond. *Review of Research in Education, 32*, 187–240.

Nelson-Barber, S., & Lipka, J. (2008). Rethinking the case for culture-based curriculum: Conditions that support improved mathematics performance in diverse classrooms. In M. Brisk (Ed.), *Language, curriculum & community in teacher preparation* (pp. 99–123). Mahwah: Lawrence Erlbaum Associates.

OECD. (2016). *PISA 2015 results: Excellence and equity in education* (Vol. I). Paris: OECD Publishing. Retrieved from https://doi.org/10.1787/9789264266490-en

Richards, J., Hove, J., & Afolabi, K. (2008). *Understanding the Aboriginal/non-Aboriginal gap in student performance: Lessons from British Columbia* (Commentary No. 276). Toronto: C.D. Howe Institute.

Rickard, A. (2005). Constant perimeter, varying area: A case study of teaching and learning mathematics to design a fish rack. *Journal of American Indian Education, 44*(3), 80–100.

Russell, G. (2016). *Valued kinds of knowledge and ways of knowing in mathematics and the teaching and learning of mathematics: A worldview analysis* (Unpublished doctoral dissertation). University of Saskatchewan, Saskatoon, SK.

Russell, G. L., & Chernoff, E. J. (2013). The marginalisation of Indigenous students within school mathematics and the math wars: Seeking resolutions within ethical spaces. *Mathematics Education Research Journal, 25*, 109–127.

Skovsmose, O. (2016). Mathematics: A critical rationality? In P. Ernest, B. Sriraman, & N. Ernest (Eds.), *Critical mathematics education: Theory, praxis, and reality* (pp. 1–22). Charlotte: Information Age Publishing Inc.
Truth and Reconciliation Commission (TRC). (2016). Home page. Retrieved from http://www.trc.ca/websites/trcinstitution/index.php?p=39
U.S. Congress House of Representatives Subcommittee on Early Childhood, Elementary and Secondary Education (CHRSECESE). (2008). *Challenges facing bureau of Indian education schools in improving student achievement*. Washington, DC: U.S. Government Printing Office.
Wilder, R. L. (1981). *Mathematics as a cultural system*. Oxford: Pergamon Press.
Willoughby, S. S. (1967). *Contemporary teaching of secondary school mathematics*. New York: Wiley.
Woolford, A., Benvenuto, J., & Hinton, A. L. (Eds.). (2014). *Colonial genocide in Indigenous North America*. London: Duke University Press.