Indigenizing University Mathematics

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Education Notes bring mathematical and educational ideas forth to the CMS readership in a manner that promotes discussion of relevant topics including research, activities, issues, and noteworthy news items. Comments, suggestions, and submissions are welcome.

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The Canadian mathematical community has been going through a slow and painful process of learning and accepting the fact that the discipline of mathematics has contributed to the colonization of Indigenous communities and peoples.

In the words of Edward Doolittle, an Associate Professor at First Nation University of Canada:

> *"Mathematics is how they really got us," said one residential school survivor to me. The issue has not been studied at all, to my knowledge, but it seems likely to me that in residential school the power of mathematics was misused, as were the other residential school subjects, as a tool for colonization and repression. The study of that issue is within the domain of mathematics education, but all mathematicians and math educators should be aware of the potential of mathematics to do harm as well as good. (Doolittle, 2020)*

Ubiratan D'Ambrosio, a Brazilian mathematics educator, extensively wrote about the role of mathematics in suppressing Indigenous knowledges across the globe.

For example, D'Ambrosio relates colonialism and mathematics (and science and technology) in the following way:

> *As part of the colonial strategy of not recognizing structured knowledge of the conquered, particularly in science, technology and mathematics, mathematical ideas of the peoples of different regions of the world*

> *have been disregarded. Part of this strategy is the belief, still predominant, that Western mathematics is the privileged manifestation of the rationality of the human species, hence universal and culture-free. The emergence of ethnomathematics, as a research field, is the result of the recognition that every cultural group develops, as a result of its rationality, its own ways and styles of explaining, understanding and coping with their environment. (D'Ambrosio, 2006)*

Consequently, the mathematical community faces increasing expectations from students, institutions, and wider Indigenous and non-Indigenous communities to address an array of questions from the role of mathematics in the process of colonization to strengthening connections between Indigenous knowledge (as the holistic total of an Indigenous peoples' understanding of the world) and academic mathematics, to creating a learning environment in which Indigenous learners could fulfill their mathematical potentials; and finally, to exploring perspectives on what it all means.

To meet these expectations and as a part of its responsibility to contribute in a meaningful way to the process of reconciliation, in the recent year the CMS welcomed at its semi-annual meetings several sessions that aimed to address various topics related to the relationship between mathematics and Indigenous communities and their cultures and traditions:

- At the CMS Summer 2021 meeting, Darja Barr (University of Manitoba), Benoit Dionne (University of Ottawa) and Emily McKinnon (University of Manitoba) co-organized a session "Transitioning to University: Indigenous Perspectives on Post-Secondary Mathematics." The session was built around the following question: "How can university and high school instructors, administrators, and other stakeholders help to support Indigenous students to success in first-year university mathematics courses?"
- At the CMS Summer 2019 meeting, Douglas Farenick (University of Regina) and Keith Taylor (Dalhousie University) co-organized a session "Indigenization and Reconciliation in Mathematics." The session focused "on hearing from experts and individuals experienced with indigenization/reconciliation in the university contexts of teaching and research."
- At the CMS Winter 2018 meeting, Darja Barr (University of Manitoba), Shawn Desaulniers (University of Alberta), Edward Doolittle (First Nations University), and Veselin Jungic (Simon Fraser University) co-organized a session "Indigenization and Reconciliation through University Mathematics: Why, When and How?" (Barr at al., 2019) The session participants were invited to address the following two questions: *Why, when, and how the mathematical community can contribute to the process of the reconciliation inside and outside of our college and university math classrooms? How can the Canadian mathematical community come together to reduce the drastic educational achievement gap between Indigenous and non-Indigenous peoples?*

Clearly, the three above listed sessions overlapped in many ways. For example, each of them had a strong teaching/educational component.

In our view, this overlap comes from the fact that the Canadian mathematical community is facing complex historical, political, cultural, scientific, and educational issues that are rooted in the role that mathematics has played in the process of colonization. And, as a community, we are still in the early stages of grasping and understanding that role and its many consequences.

The common denominator for the above listed sessions was an effort to make space within the Canadian mathematics community to further explore what it meant to Indigenize university mathematics, both in education and research.

With this in mind, it should not be a surprise that the Canadian Mathematics Society (CMS) Winter Meeting session entitled "Indigenizing University Mathematics" revisited many of the themes that were discussed during the earlier CMS meetings.

In the early fall 2021, we invited a group of friends and colleagues to join us for the Winter 2021 CMS meeting and share their thoughts, knowledge and experiences with the following questions:

- What does it mean to Indigenize university mathematics?
- What is the role of mathematics in the process of colonization?
- What are the roles of Indigenous mathematicians and mathematics educators in the process?
- What are the roles of non-Indigenous mathematicians and mathematics educators in the process?
- What must be done to unleash the mathematical potential among Indigenous learners?

- How can one strengthen connections between Indigenous knowledge and academic mathematics?
- What does the wider mathematical community—including students of mathematics—need to learn to meaningfully contribute to the process of reconciliation between Indigenous and non-Indigenous peoples in Canada and across the globe?
- Anything else related to this topic that you wish to address.

The major difference between the recent session and the previous CMS sessions was, in the fact, that all invited presenters and panelists were self-identified Indigenous scholars.

The session speakers represented the cross-section of the Indigenous mathematical community.

The presenters and panelists came from Australia (Michael Donovan, Macquarie University); Canada (Melania Alvarez, University of British Columbia; Broderick Causley, McGill University; Kori Czuy, University of Calgary; Shawn Desaulniers, University of Alberta; Edward Doolittle, First Nations University of Canada; and Florence Glanfield, University of Alberta); and the United States (Henry Fowler, Navajo Institute for Technology; Robert Megginson, University of Michigan; Belin Tsinnajinnie, Santa Fe Community College; and Kamuela Yong, University of Hawaii).

The strong international component of our session reflected the fact that all the presenters have been involved in at least one of two relatively new global initiatives. One such initiative is the community "Indigenous mathematicians" (https://indigenousmathematicians.org/) coordinated by Kamuela Yong with the overarching goal to "build community both with those [Indigenous mathematicians] living in the present and those in the past." The other initiative is "Indigenizing University Mathematics" (https://carma.newcastle.edu.au/meetings/ium/index.html) led by Judy-anne Osborn, University of Newcastle. As part of this initiative, a large international group of Indigenous and non-Indigenous scholars collaborates and shares "knowledge and worldviews from within both Indigenous cultures and the cultures of mathematics and its allied disciplines." Such initiatives mirror a growing base of global efforts to engage with Indigenizing mathematics established from South Africa to Chile.

We cannot resist addressing this apparent contradiction, that Indigenous scholars who are, by definition, firmly rooted in their local cultures, connect globally to establish the universal truths implicit/explicit with the following characterization of a convex n-gon:

If $n \geq 4$, then n points in the plane in general position form a convex polygon if, and only if, every four of them form a convex quadrilateral.

Similarly, a shape of the idea of Indigenizing university mathematics emerged through presentations that addressed a number of very specific issues. They create a vision of the importance of place-based mathematical practices across cultures, from inscribing a regular hexagon (Fowler) to the use of Polynesian nautical and astronomical concept knowledge to build place-based pre-calculus (Yong)—reimagining Optimization. Within the session, through the breadth of approaches, we start to visualize a conceptual knowledge framework and space for Indigenous mathematics. Over the course of the day the audience learned about Navajo ethnomathematics (Fowler); about the challenges and success in the process of creating a university mathematics training program for aspiring Indigenous teachers (Desaulniers); about providing real mathematical support for in-service teachers working with Indigenous students and Indigenous students preparing for post-secondary education (Alvarez); about redesigning and enhancing a standard university mathematics course by incorporating the elements of local Indigenous knowledge (Yong); about looking at the side of the academic mathematics that is experienced, relational, relevant, and even spiritual (Czuy); about implementing Indigenous pedagogy and heutagogy as a way to build a student-centered approach to teaching mathematics (Causley); about examining from an Indigenous person's perspective the meaning of Indigenization of university math (Donovan); about how current diversity and inclusion efforts in mathematics and mathematics education directly empower Indigenous communities (Tsinnajinnie).

In addition, two prominent Indigenous mathematicians and pronounced leaders of the mathematical communities in Canada and the USA, Doolittle and Megginson, described their own experiences working within Indigenous communities and within academies. This included their reflections about acting, over many years, as the bridges between the two communities: laying groundwork and offering insight into the cultural importance of spirituality and mathematics, allies, and language in the pursuit of past-present-future Indigenous mathematics.

We feel the need to underline something that the reader has probably noticed already, the wide range of topics—from ethnomathematics to various practices in teaching mathematics to some of the fundamentals of academic mathematics—covered during the session.

In our view, this clearly demonstrated diversity of interests of Indigenous mathematicians and mathematics educators is directly proportional to the level of complexity of the process of Indigenizing university mathematics, but also to the fact the Indigenous academic community is a vibrant and very active segment of the modern academia.

The message that emerged at the end of the session was that the process of Indigenizing University Mathematics was not prescriptive nor one set of general rules to be followed.

The 2021 CMS session "Indigenizing University Mathematics" confirmed that Canadian mathematicians and mathematics educators are willing to listen to and learn from our Indigenous colleagues from across the world. This assures us that, as a community, we can work together to help repair the damage caused by years of benign neglect and intentional harm for the benefit of the Indigenous learners and users of mathematics, but also for the benefit of our beloved subject.

References:

[1] Barr, D., Desaulniers, S., Doolittle, E., & Jungić, V. (2019) Indigenization and Reconciliation through University Mathematics: Why, When and How? CMS Notes, 51(2), pages 9-11.

[2] D'Ambrosio, U. (2006) The Program of Ethnomathematics and the challenges of globalization. Circumscribere: International Journal for the History of Science 1, 74-82.

[3] D'Ambrosio, U. (2017) Ethnomathematics and the pursuit of peace and social justice. Educação Temática Digital 19(3), 653-666.

[4] Doolittle, E. (2020) Mathematics and Reconciliation. CMS Notes, 52(2), Online: https://notes.math.ca/en/article/mathematics-and-reconciliation/.