Relationships and Reciprocity Towards Decolonizing Mathematics Education

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In this study, we focus on the importance of co-constructing reciprocal relationship as a step towards decolonizing mathematics education. Research teams comprising Anishinaabe and Métis leaders, artists and educators and non-Indigenous educators collaboratively explored connections between the mathematics inherent in Indigenous artistry, design and technology and the mathematical content in the Ontario curriculum. Contextualizing research ethics was imperative. While the initial focus was on the co-planning and co-teaching of units of mathematics instruction based on Anishinaabe or Métis cultural practices, we realized that the work was primarily about developing ethical relations, which prioritized Indigenous knowledge systems and positively influenced mathematical understanding.

Keywords: culturally responsive Mathematics education

OBJECTIVES

As part of a long-term multi-site research study, nine teams across Ontario comprising Indigenous leaders, artists, educators and non-Indigenous educators worked together to explore the mathematics inherent within Anishinaabe or Métis cultural practices. The projects took place in different community settings that varied in terms of contexts and participants. Each individual project was at the local grassroots level and driven by the views, opinions, resources, and interests of participating community. We engaged decolonizing research ethics with a commitment to making the research meaningful for community partners by establishing consensual collaborations, where different people brought different expertise and experiences to the work (Whetung & Wakefield, 2019). Initially our goal was to demonstrate the efficacy of this approach in order to transform Canadian mathematics education into a form that respects both Western and Indigenous traditions. However, through the processes of co-planning, co-teaching and co-reflecting, we realized that the work was primarily about lifting up Indigenous knowledge and shifting research practices towards an emphasis on ethical relationality (Donald, 2012).

THEORETICAL FRAMEWORK

In order to make math meaningful and relevant for First Nations and Métis students we made explicit connections to the mathematics inherent in Anishinaabe or Métis culture, and provided an opportunity for

all students to experience culturally sustaining mathematics instruction. We brought together two cultural knowledge systems: the mathematical knowledge inherent in traditional Indigenous technology, design and artistry and the mathematics found in the Ontario curriculum. We looked to ethnomathematics as a framework, which views school mathematics as one of many diverse mathematical practices that is no more or less important than mathematical practices that have originated in other cultures and societies (Wagner & Lunny Borden, 2012; Mukhopadhyay et al., 2009; D'Ambrosio, 2006).

To make these cultural-mathematical connections, we identified relational protocols from Indigenous knowledge systems to build long-term relationships with community that are grounded in respect, relevance, reciprocity, and responsibility (Archibald et al., 2019; Kirkness & Barnhardt 1991). Placing relationships at the heart of this work aligns with Indigenous research methodologies that ask not whether results are valid or reliable, but whether those entering into the research process have fulfilled their roles and responsibilities within the relationship (Wilson, 2001). We were guided by the people we worked with and co-created meaningful approaches to both mathematical instruction and to research with respect to methodology, analysis and the dissemination of findings. This commitment to ethical relationality allowed us to "build bridges, to render consensus emerging among our own conversations intelligible to a wider mainstream audience in dire and urgent need of alternative, complementary ways of knowing and being (aka epistemologies and ontologies)" (Darnell, 2018, p.231).

METHODS

Project sites included two federal schools each within a First Nation and three provincially funded public schools each with ties to a specific First Nation. Additionally, we worked in four classrooms in urban settings in which community research team members were invited via the board's Indigenous Education Advisory Committee and so did not represent one specific First Nation, but rather urban Indigenous communities that created themselves as "intimate, human, and self-defined spaces" (Smith, 2012, p.127).

We followed a cyclical process that began in each community with an initial consultation to ensure the work was grounded in local circumstances and responsive to the community's educational goals. We were the "holders of space… creat[ing] the space to put Nishnaabeg [and Métis] intelligence at the center and to use its energy to drive the project[s]" (Simpson, 2017 p.15). Throughout the projects, team members engaged in ongoing consultation with community over the course of months or years. After initial consultations, project team members then co-planned and co-taught a particular form of Indigenous technology and/or artistry chosen by the community either based on their own priorities for cultural revitalization, or based on the funds of knowledge of participating artists. The activities included different kinds of beading (loom, medallion and peyote stitch), birch bark basket making, moccasin making, and Métis finger weaving. Teams then co-analyzed video recordings of the lessons, and reflected on the experience in terms of cultural and mathematical understanding.

RESULTS

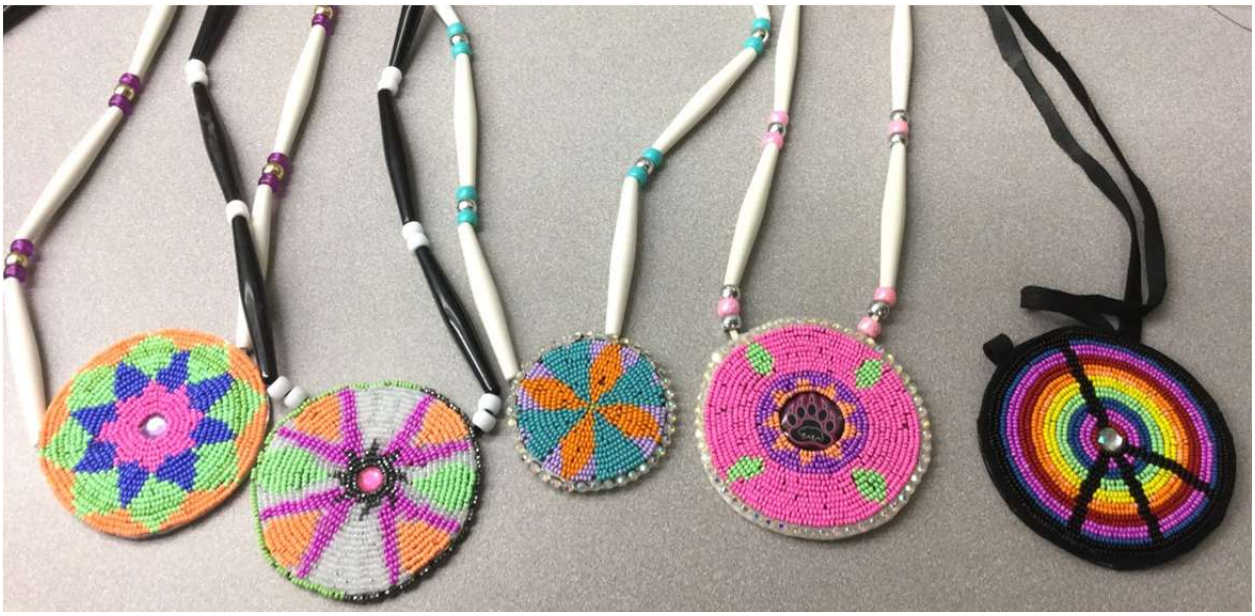
Student Experiences

Centering instruction within Indigenous knowledge created experiential connections to mathematics as students engaged in the cultural activities the community partners brought to the classroom. The learning began with cultural teachings and the significance of activity in Anishinaabe or Métis culture. Students then participated in the activity, through which the mathematics emerged. For example, when learning to loom bead, students investigated repeating patterns, and algebraic, proportional and spatial reasoning (e.g., determining what the *nth* column of a pattern would look like, or how to reflect or rotate the pattern core (Fig. 1).

FIGURE 1
LOOMWORK WITH A REFLECTED PATTERN CORE

Creating circular medallions lead to explorations of linear and quadratic growth (Fig. 2) (Beatty et. al., 2020; Wiseman et. al., 2020; Beatty & Ruddy, 2018; Beatty, 2018; Beatty & Blair, 2015).

FIGURE 2
CIRCULAR BEADED MEDALLIONS



Through these explorations, the students formed strong relationships with community partners, and their reflections highlighted the importance of these relationships in their learning.

> This project was the best days of the school year. The beading project was a better way to learn math than normal math worksheets because it's hands-on and has better results, and it's a bit of a history lesson too because you learn about how Métis people would learn and practice math. My favourite element over all was the people. Everyone was always smiling and laughing. They never left our sides without giving some sort of help. I really enjoyed the attitudes of the grown ups in the room – they were interesting people to be around and to hear stories from. I would much rather continue this project for the rest of the year, not only because of the beading, but mostly because of the people who made some of the best days of my life possible.
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> Grade 6 student written reflection

Community Partners Experiences

Attending to the mathematics of the processes of designing and creating artifacts, and the mathematics of the finished products, led artists to recognize that they had already been thinking mathematically within their artistry. This was a reciprocal revelation in that it transformed how we see Indigenous artistry, but also transformed how we see mathematics. Community partners developed deep understanding of complex mathematical concepts, which strengthened their awareness of the place mathematics has in Indigenous culture, and strengthened their own cultural and mathematical self-identities. Two examples are presented below.

C.R. is an Algonquin beader and has been part of the study for eight years. In that time, she has gone from developing a comfort with math, an example of reciprocity, to becoming a trailblazer in this work by mentoring other Indigenous artists in communities across the province. She has presented at research conferences, won a University award for her role in the study, been co-applicant on a number of federal research grants, and co-authored a book chapter in a resource on mathematics instruction. Collaborating in this work has been transformative for C.R., who now refers to herself as an ethnomathematician, and contrasts this to the messaging she received throughout her childhood.

> When I was in school I was told that Native people can't do math. I was told that my entire education in elementary school and in high school. When I went to college I was part of the first cohort of Native Community and Social Development, and there was a math component. And the students stopped going to that program because of the math, so the college dropped the math component. So, it's not just me. We've been told our whole lives we can't do math. That's why I do this work, that's what motivates me every day. I'm not going to let another kid grow up believing that they can't do math because that's awful. I didn't know I could do math until I was over 40 years old. And now I teach it.

Another example is L.M., a Métis artist and expert beader, who had trepidation about participating in a study focused on making mathematical connections. During an interview after the first two projects she was involved with, L.M. was asked what she would be taking away from the experience.

> Math, definitely. I see it in a whole different light now. Well before, I just did beading, that's the way I was taught. I wasn't taught by anybody that it included math. And when they were breaking it down into the math components, even designing, I'm thinking I do that, but I never knew I did it. I just didn't know the names. So then I got really excited. Now I'm looking at my designing and everything else more so on the math side of it, rather than just designing. Like, it's amazing! At first I didn't understand the math, but I was able to still help out, and then when I did get the math it was…ok…a whole new door's opened! I like beading more now!

Since this interview, L.M. has co-taught both the skill and the mathematics of beadwork in a number of elementary classrooms. She has also presented to teachers at a school board-level professional development learning fair.

In each project, the artists we worked with did not initially perceive themselves as mathematical thinkers, however, through the process of co-planning and co-teaching, and particularly from working and learning with students, they came to understand that they had always understood the mathematics of their artistry, but had not made a formal connection to "school math". This project provided an opportunity for artists to recognize the culturally embedded mathematical competencies with which they had already been engaging.

Settler Educator Experiences

Non-Indigenous educators came to recognize and appreciate the complex mathematics that emerged during the projects. "This project has opened my eyes. When we bring Algonquin culture into our school

and show that we value it, the learning that comes from it is phenomenal. It's like mathematics that I've never dreamed of!" They also unpacked their own positions within the work and their responsibilities, including an appreciation of the expertise of community artists, and their commitment to continuing the work in a good way.

> The community team members opened up so many pathways for us with the rest of the community. Now we have meetings with Elders and ask for permission for the work we're going to do. And having community working with us in the classroom means we know we're doing the work in a good way, because before, we were never sure. We weren't sure if we were doing a service or a disservice to our First Nations students, or to the community. These connections have been so beneficial. It's really phenomenal to be part of this change. We're building bridges, we're talking, we're creating dialogue and we're moving forward together.
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> Grade 6/7 teacher interview

CONCLUSION

Decolonizing education through reconciliation is a focus of the final report of Canada's Truth and Reconciliation Commission *Calls to Action* (2015). We believe that ethical relationality may be a powerful step towards reconciliation, and therefore decolonization, in the domain of mathematics education. In our work, decolonization influenced both the teaching of mathematics, and also the participatory action research process. The importance of relationships, and their connection to reconciliation, was summarized by an Anishinaabe research team member:

> When we bring community into the classroom, we need to ask, what are you giving back? And for me, that's where I see the beauty of this project – that giving back to community partners. Watching their relationships developing with the students, and the children remembering that relationship. For example, in one classroom we were in the children were talking about how it was the best thing they'd done all year because of the relationships with the people in the room. Giving the community partners an opportunity to build relationships with youth, having their skills honoured, that's reciprocity. That's reconciliation.

Educational researchers have a responsibility to work with community to prioritize Indigenous knowledge and ways of knowing. Although the content of the work presented here is mathematics, what emerged more significantly in all of the projects was the centrality of reciprocal relationships.

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