
Learning Mathematics through Birch Bark Biting: Affirming Indigenous Identity

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Focused on supporting mathematics learning in Mi'kmaq communities in Atlantic Canada, this research program examines the implementation of culturally-based inquiry units in Mi'kmaq schools. Drawing from the traditional community practice of birch bark biting, this article demonstrates how students (and their teacher) were invited to learn together, exploring as an aspect of Mi'kmaq culture while also connecting this knowledge to relevant mathematics outcomes. The project uses an indigenist methodology to explore the impact of such pedagogical approaches on mathematics teaching and learning in Mi'kmaq schools. Stories of students learning mathematics while birch bark biting are shared.

Context

As Canada's Aboriginal communities re-establish their self-government and self-determination, there is a need to develop sustainable economies and manage natural resources within the context of a growing population and insufficient infrastructure. Aboriginal leaders want the younger generations to acquire the knowledge and skills to address these challenges. Such capacity-building requires adequate education; currently, however, too few Aboriginal students are choosing to pursue studies in essential skill areas, such as mathematics and science. With growing attention on the academic achievement of Aboriginal children, local education authorities and federal and provincial governments are exploring strategies to enhance the learning experiences of Aboriginal youth.

It has been argued that disengagement from mathematics emerges as a result of the conflict between Aboriginal culture and the cultural values embedded in school-based mathematics programs (Cajete,

1994; Hanks & Fast, 2002). The marginalization of Mi'kmaw youth from mathematics has been a long-standing concern in Mi'kmaw communities and this concern extends to many Aboriginal communities across Canada. The Minister's national working group on education (Indian and Northern Affairs Canada, 2002) stated that a key area to be addressed in Aboriginal education in Canada is the development of culturally relevant curricula and resources in areas of mathematics and science. Lunney Borden (2010) has shown that a disconnect between school-based mathematics and Mi'kmaw ways of reasoning mathematically can impact mathematics learning for Mi'kmaw students. The author has argued that the lack of attention to value differences, the use of inappropriate pedagogical strategies, and a failure to attend to ways of knowing embedded in Indigenous languages can make mathematics learning problematic for Mi'kmaw students. As a result, many children choose to opt out of mathematics because the cost of participation is too high, demanding that they deny their own worldview in order to participate in the dominant view of mathematics. Doolittle (2006) has elaborated on this cost of participation for Aboriginal students having cautioned "as something is gained, something might be lost too. We have some idea of the benefit, but do we know anything at all about the cost?" (p. 19).

Mi'kmaw Kina'matnewey (MK), based in Nova Scotia, Canada, stands out as an example of a Regional Aboriginal Education Authority that is experiencing success. These schools boast a graduation rate that in the past 5 years has been between 87.0% and 89.3% (Mi'kmaw Kina'matnewey, 2014) in stark contrast to the often-reported Canadian national graduation rate for Aboriginal children of about 48% (Assembly of First Nations, 2010). MK schools are striving to meet curriculum expectations while maintaining a strong sense of Mi'kmaw cultural identity. One example of such cultural integration is in the area of mathematics. Since 2007, thousands of Mi'kmaw children have been participating in Show Me Your Math (SMYM), an annual program that invites them to investigate the mathematics in their own community context. The SMYM program showcases the mathematics inherent in Mi'kmaw culture through celebrating student projects from all grade levels.

SMYM was developed by myself and Dr. David Wagner along with teachers in MK schools in an attempt to address the marginalization of Mi'kmaw youth from mathematics by helping them to

see that there is a considerable amount of mathematical (and scientific) knowledge in their own community heritage. One of the benefits of the program we have seen is the development of a sense of “Wholeness [that] resists fragmentation” and creates “quality mathematics experiences [that] require cultural synthesis bringing together cultures and values from mathematics and the community, personal holism including the child’s experiential, conceptual and spiritual development, and intergenerational interaction.” (Lunney Borden & Wagner, 2011, p. 379)

In recent years, SMYM has become increasingly more popular with MK students and their teachers, however curriculum pressures have resulted in a call for closer alignment with provincial curriculum expectations so that teachers can integrate SMYM projects into their classroom practices while still addressing specific curriculum outcomes. In an effort to address this expressed need, I had began working with teachers and elders to build units of work from the ideas in SMYM student projects. Inspired by Doolittle (2006) who has suggested it would be helpful to “consider the question of how we might be able to pull mathematics into indigenous culture rather than how mathematics might be pushed onto indigenous culture or how indigenous culture might be pulled onto mathematics” (p. 22) I have aimed to begin with community practice as a starting point.

As a result of recent funding obtained for the expansion of SMYM, we were able to develop community-based inquiry units that begin within community practices. These projects build upon Doolittle’s (2006) idea of pulling in mathematics by beginning in aspects of community culture where the already present, inherent ways of reasoning within the culture can help students to make sense of the “school-based” concepts of mathematics in the curriculum. One goal of this work is to have teachers and students learning alongside one another as they explore practices that are relevant to the community. As such, these projects have been called Mawkinumasultinej! Let’s Learn Together! as a way of emphasising this focus on learning together. Many projects have been initiated in schools such as eels and eel fishing, quill work designs, paddle-making, and bead work. In this paper I will share stories from the Birch Bark Biting units done with students in grades 5, 6, and 7 and describe how these units have impacted learning for both the teacher and the students.

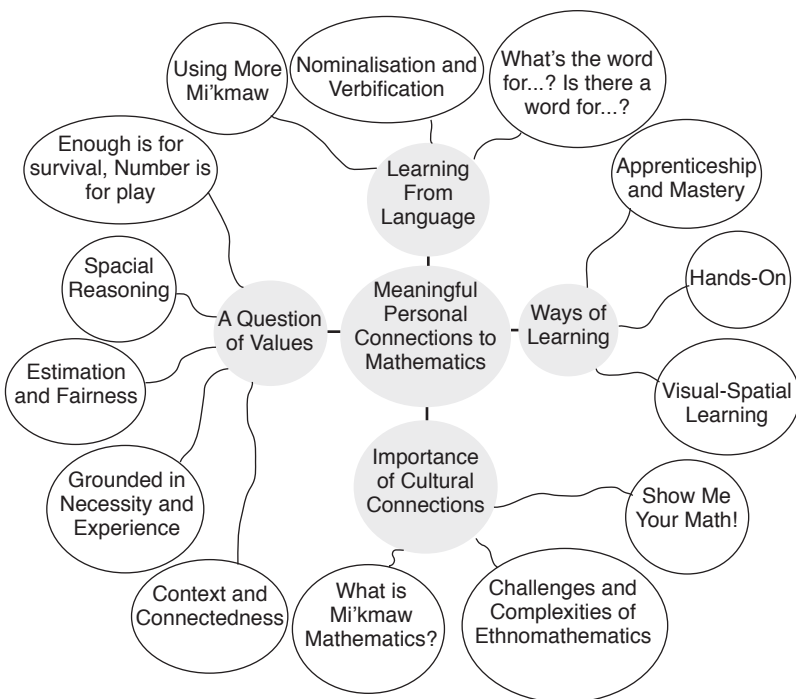


Figure 1: A framework

Building from a Framework

I developed a framework for transforming mathematics education during my doctoral research (Lunney Borden, 2010). The framework can be seen in the model below (see Figure 1) that emerged from conversations with teachers and elders in two Mi'kmaw community schools as we discussed the issues and complexities that arise in mathematics teaching and learning in Mi'kmaw schools. Four key areas of attention for transformation emerged as themes: 1) the need to learn from Mi'kmaw language, 2) the importance of attending to value differences between Mi'kmaw concepts of mathematics and school-based mathematics, 3) the importance of attending to ways of learning and knowing, and 4) the significance of making ethnomathematical connections for students. Each of these will be explained in more detail below.

Learning from Language

Although interconnected, each of the themes can be linked to the idea of learning from language, which emerged as an overarching theme in this work. Examining the Indigenous language of a given community context would provide a starting place for transforming mathematics teaching and learning. Given that the ways of thinking are embedded in Indigenous language, it can be helpful for teachers to understand how the language is structured and used within the community.

It may be helpful to ask questions such as “What is the word for...?” or “Is there a word for...?” to better understand how mathematical concepts are described in the language (See Lunney Borden, 2012). Gathering words that can be used to describe mathematical concepts, provides insight into concepts that may prove to be potential strengths for building a mathematics program. Similarly, awareness of mathematical concepts that have no translation in the Indigenous language exposes the taken-for-granted assumptions that are often present in existing curricula.

Understand the underlying grammar structures of an Indigenous language can also support teaching and learning. The prevalence of nominalisation in mathematics stands in direct contrast to the verb-based ways of thinking inherent in the Mi'kmaw language (see Lunney Borden, 2011). This is an important issue for teachers to consider. Looking to “verbification” as an alternative may help to create a more engaging and rich curriculum for Indigenous learners.

A Question of Values

It is also important for educators to think about how mathematical ideas are used and valued in the community context. It is important to understand how numerical and spatial reasoning emerge in the context of the community culture. This study has shown that spatial reasoning was highly valued as it pertained to matters of survival. Numerical reasoning was seen as useful in play. If we consider mathematics to be about examining quantity, space, and relationships (Barton, 2008) then it becomes important to build learning experiences that value these concepts in a way that is consistent with, rather than in opposition to, the way these concepts are valued within the

culture. There is a need to build mathematics learning experiences for Mi'kmaw students from a basis of spatial reasoning.

Ways of Knowing

Language and values also influence the preferred ways of learning in any community context. It was evident in this community context that a mathematics program should provide children with opportunities to be involved in learning focused on apprenticeship with time for mastery, and hands-on engagement with concrete representations of mathematical ideas. Furthermore, building from a valuing of spatial reasoning, a mathematics program should place visual spatial learning approaches on equal footing with the already dominant linear-sequential approaches, providing more ways to learn so that more students can learn.

Cultural Connections

In addition to community language, values, and ways of learning being included in a mathematics program, it is also essential to make meaningful and non-trivializing connections to the community cultural practices. This involves examining how the school-based mathematics can be pulled in through identifying types of reasoning inherent in the community that can help students to make sense of the school-based mathematics. It also means creating learning experiences that help students see that mathematical reasoning is a part of their everyday lives, and has been for generations. The success of Show Me Your Math suggests that inviting students to be mathematicians who investigate mathematics in their own community contexts could also be an important component of a culturally based mathematics program.

Methodology

It is appropriate to first situate myself and explain my role in this work. Although I am not Mi'kmaq, I lived and worked within a Mi'kmaw community for 10 years and during that time I learned the

language and culture and become engaged in the overall life of the community. In 2005, when I left the job I loved to begin my doctoral studies I did so with a sense of sadness for leaving but a commitment to continue to work tirelessly alongside community members to improve the educational experiences of Mi'kmaw children. Yet within the academy, I was constantly being questioned as to why I felt it was my place to do such work and I even began to doubt myself. At that point I returned to the community that had become my home to seek advice from respected community members.

I shared my concerns about my role in this work in a conversation with two Mi'kmaw colleagues. Their responses were reassuring. One colleague spoke about the time I had spent in the community, the way I had learned the language and the culture, and assured me that he knew that I had come to work with the community. The other jokingly asked me if I wanted to quit now. His teasing was a way of reminding me that not only did I have the privilege to do this work, I had an obligation to do it. They had shared with me the language, the culture, the ways of knowing and being; they gave to me and now I was in a position to give back in a way that honoured the community. The work I do now honours that commitment.

Understanding the complexities of doing research in Aboriginal communities I worked to mitigate the potential harms, by utilizing an Indigenist methodology. The term Indigenist research was first introduced by Rigney (1999) and is based on three interrelated principles: resistance, political integrity, and privileging Indigenous voices. Adopted by Indigenous and non-Indigenous scholars, it is seen as a paradigm for decolonizing research (Denzin, 2005). This approach “research[es] back to power” (Smith, 2005, p. 90) and holds a “purposeful agenda for transforming the institution of research, the deep underlying structures and taken-for-granted ways of organizing, conducting, and disseminating research and knowledge” (p.88).

Kovach (2009) has argued that “Indigenous methodologies, by their nature, evoke collective responsibility” (p. 178). Furthermore, Kovach has stated:

Specific responsibilities will depend upon the particular relationship. They may include guidance, direction, and evaluation. They may include conversation, support, and collegiality. Responsibility implies knowledge and action. It seeks

to genuinely serve others, and is inseparable from respect and reciprocity. (p. 178)

This research is guided by *mawiknutimatimk* (coming together to learn together) a Mi'kmaw term used to describe the process of people coming together to discuss an issue or solve a problem (Lunney Borden & Wagner, 2013). It implies that everyone comes to the table with gifts and talents to share—everyone has something that they can learn. It conjures an image of a community of learners working in circle where all members are equally important and necessary. Each participant who joins in the circle has something unique to contribute. With *mawiknutimatimk* there is an embedded understanding that the importance of relationships and the interconnectedness of participants must be honoured. It was through relationship that the birch bark biting unit idea emerged.

Stories of Birch Bark Biting

The idea for the birch bark biting inquiry project emerged somewhat unexpectedly. I was meeting with two elders to discuss some of the projects students had done at the annual math fair to think about ways these might be expanded upon to create classroom teaching ideas. As she spoke with one elder, Josephine, they discussed games that might have been traditionally played by children. The intent of this discussion was to build from games to possible counting and quantity concepts, however this suddenly changed when Josephine declared “You know, when I was young, my mother would peel thin strips of bark off the logs and ask us if we could fold it and bite shapes into it.” Aware of the art of birch bark biting in other cultural communities in Canada and intrigued by the mathematical reasoning that would be needed to bite shapes into folded bark, I excitedly asked Josephine more about this. Josephine shared that she recalled some people doing birch bark biting as a pass time when she was young but was unsure if anyone still was able to do it.

She showed me how to fold paper to model how one might fold bark for biting, always folding through the centre. We folded the bark in half and then folded it in half again by folding the original seam onto itself. I asked her if there was a word to describe that action

of folding and she replied, “Yes, Tetpaqikatu!” I asked her what that meant and she laughed and said, “Fold it the right way.” After sharing ideas and looking up some birch bark biting pictures online together, she told me I should try to learn more about it. So I did.

In following up on the conversation I came across an article that demonstrated that birch bark biting was indeed a historical part of the Mi’kmaw community:

That she was “the last one that can do it” was the same phrase echoed in 1993 by Margaret Johnson, an Eskasoni Micmac elder from Cape Breton. Continuing research has revealed that two other Micmac women – including Johnson’s sister on another reserve – can also do it. (Oberholtzer and Smith, 1995, p.307)

I had known both Margaret, who was affectionately known as Dr. Granny, and her sister, Caroline Gould, who had resided in the community where I had taught and was a well-respected elder who often visited the school. Unfortunately both women had already passed away but both had been highly respected elders in Mi’kmaw communities known for the commitment to language and culture. This inspired me to share what I was learning with teachers and students and by learning together, birch bark biting was revived in Mi’kmaw communities.

Birch bark biting involves folding thin pieces of bark and biting shapes into the bark to create designs. The act of folding the bark presents an opportunity for students to think about fractions, angles, and symmetry. Creating the designs draws in geometric reasoning and visualization of geometric shapes. In our work with students, we have seen a deepened understanding of fractions as part of a whole, of geometric properties of 2D shapes, of symmetry, and of transformational geometry. In fact almost all of the grade 5, 6 and 7 curriculum outcomes for geometry can be discussed when exploring birch bark biting, however we did not begin with the outcomes, we began with the birch bark bitings.

I introduced the unit by sharing the story of the conversation between I had with Josephine. I showed students pictures and videos of birch bark bitings I had found online and shared the story of discovering the article describing the two Mi’kmaw women who had been birch bark biters - women the students themselves knew. I also demonstrated

to students what I had learned from Josephine about folding and even brought a few of my own first attempts at creating birch bark bitings. In sharing my story of learning with the students, I invited them and their teacher to learn along with me. We would learn together.

As a group we explored creating our own birch bark bitings and some students found an instant connection to this work while others were initially a bit reluctant to want to bite the bark. Yet soon all students became very engaged in the task, spending time with the bark, working on bitings outside of school time, persistent in their desire to explore new patterns and figure out different designs. As their teacher shared “even the most reluctant ones would keep trying.” Initially, as the students were biting the bark, there did not seem to be an intentionality on what they were making, they were simply exploring various bites and examining what resulted when they unfolded the bark. Questions naturally emerged when students spent time working with the bark. For example one student wanted to be able to create an eight-point star. By working on through a series of trials, exploring various angles to make the biting had discovered what to do so that, when unfolded, the eight-point star would emerge. Holly explained that she observed him develop a sense of ownership over it once he figured it out and was then able to create these patterns with intention.

Other questions that emerged took us beyond the creation of the design to wonder about how and when to collect bark, and what would happen to the tree if we were to remove the bark at inappropriate times. Through research we learned that there are two times in the year when Mi'kmaw people would have historically taken bark from a birch tree, late summer and again in early spring when the sap is running. Given that it was not in the appropriate season for gathering bark, we worked with bark that had been previously collected. The bark we used actually emerged in rather serendipitous ways. A community member brought us a large container of bark that he had collected from felled trees that were being logged on the nearby mountain. He shared that he had collected it for Dianne and had it at home for some time. The Dianne he referenced was the late Dianne Toney, who had been a quill box maker and the inspiration for the SMYM program (see Wagner and Lunney Borden, in press). Sadly, Dianne had passed away before the SMYM program began, yet this moment reminded me of her influence on this work. Another batch of bark came from the classroom teacher who, after a birch tree fell

on her home during a storm, had kept pieces of the tree believing one day she would create something from them.

Culturally-based Learning

The birch bark biting provided an opportunity to talk about mathematics as an active and dynamic process rather than a fixed and frozen set of facts. I have argued that “verbifying” mathematics, focusing more on action and process, can support students who are thinking more in verbs. With the birch bark biting one could ask about lines of symmetry, the core of the pattern, the fractional pieces and so on, but what proved to be more effective was to shift to discussing how these designs were created. Questions such as “Where was it folded?” or “What did she bite?” or “How many pieces are we creating?” brought students to the same understanding in a way that was more focused on action and process. Students were able to then connect folding it onto itself to the lines of symmetry and the initial shapes that were bitten to the core of the pattern. There was also recognition that this core was flipped and turned to create the design.

One additional benefit of doing this project was to provide students to learn about elders in their own community who had been birch bark biters. It allowed these students to appreciate the knowledge that had been needed to do such complicated designs and to see that their elders were mathematicians too, as they too had used geometric reasoning to create their bitings. Many teachers in the school, upon seeing the designs, recalled having seen Caroline Gould making these bitings at her basket shop when they were children.

Through participation in this activity I saw students, and their teacher, engaged in meaningful learning that emerged in an authentic context. The students showed pride in having learned a nearly lost community practice. They discussed their designs and were able to talk about how they made them referencing mathematical ideas as they did so. They debated whether the core was one-eighth or two-eighths of the pattern with some students arguing that the original biting is made up not only of the top bites but the bottom bites as well. Birch bark biting provided an opportunity to learn in a way that valued wholeness and enabled students to have meaningful connections to the mathematics they were learning.

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