It All Began with a Quill Box: Reflections on Show Me Your Math

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Abstract

This paper reflects upon the numerous projects that have emerged from the Show Me Your Math (SMYM) program since 2007. SMYM was inspired by conversations with Mi'kmaw Elders about the mathematics inherent in community cultural practices. Youth from Mi'kmaw Kina'matnewey (MK) community schools and public schools engaged in similar conversations with Elders and knowledge keepers to create projects that were shared annually at the regional math fair. These examples show how mathematical knowledge has always existed in Mi'kmaw communities and how the mathematical ideas emerge from Mi'kmaw cultural values.

Introduction

In 2005, as a then doctoral student and former educator and administrator in a Mi'kmaw community school, I had the opportunity to engage in some conversations with Mi'kmaw Elders and knowledge keepers about mathematical connections to community ways of knowing, being and doing. One Elder, who I had known for ten years, shared how she made her porcupine quill boxes, beginning with a circular top made from birch bark and using a wood strip to make a ring for the top of the box. "I measure three times across and I add a thumb-width. It makes a perfect ring every time." As I excitedly exclaimed, "that's pi!" she called it common sense and shared that this knowledge had been passed down through generations of quill box makers. It was this conversation that prompted what would become the Show Me Your Math program, inviting youth in Mi'kmaw communities to explore the mathematical thinking inherent in communities' ways of knowing, being and doing. Over the years, I have had the privilege of working with teachers and students in Mi'kmaw and public schools in Nova Scotia, as they show me their math. In this paper, I will look back at some memorable projects and learning experiences that have helped me to come to understand that when we begin in interesting contexts that value and honour community knowledge systems and practices, beautiful and significant mathematics can emerge.

Figure 1: *A Quill Box Made by Dianne Toney*

Does Three and a Thumb Always Work?

This is a wonderful question to provoke learning for students in middle school and high school. This question provoked a lesson idea that became a Desmos activity that is widely used in Nova Scotia classrooms to introduce the circumference to diameter relationship that is typically referred to as pi in mathematics [2]. Students are asked to think about and share their initial insights as to whether or not this relationship will hold for all circles. Some argue it will, other recognize that as a circle becomes much larger, a thumb width may no longer be good enough to create a ring that is long enough with just a little bit of overlap.

The Desmos activity invites students to draw some circles of various sizes (See Figure 2) and to make rings using the three and a thumb rule to see if these rings will be long enough.

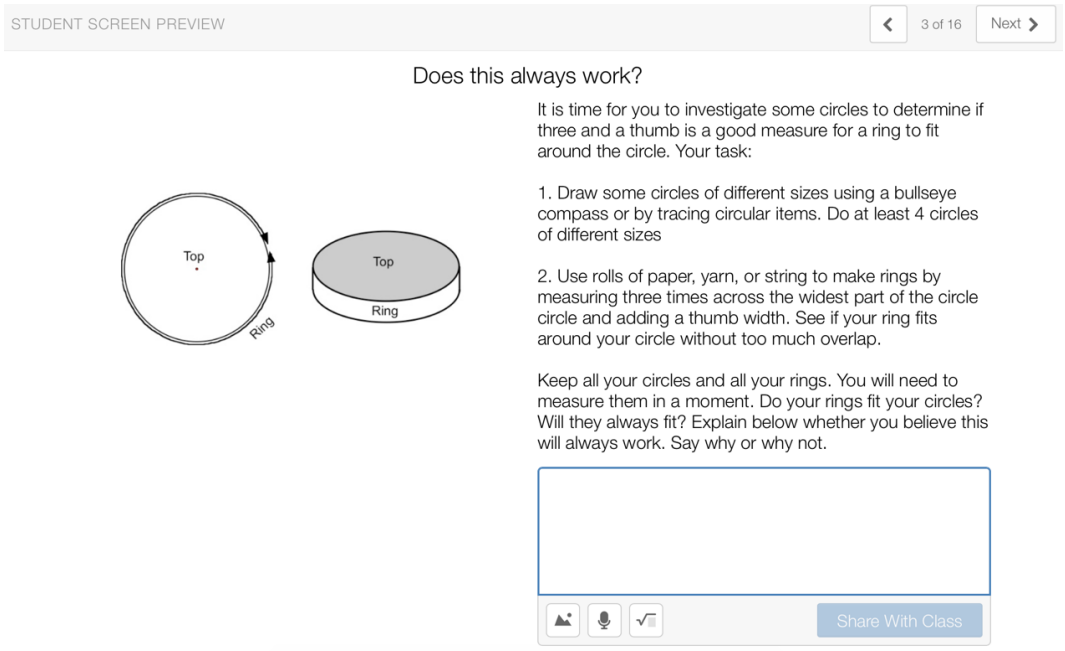

Figure 2: *An investigation slide from the Desmos activity for Dianne's Quill Boxes.*

With enough created circles and rings, students are introduced to the terms circumference and diameter. They are then invited to measure and compare these values, looking at the ratio of circumference to diameter. They then use their calculations to estimate circumference or diameter for given circles.

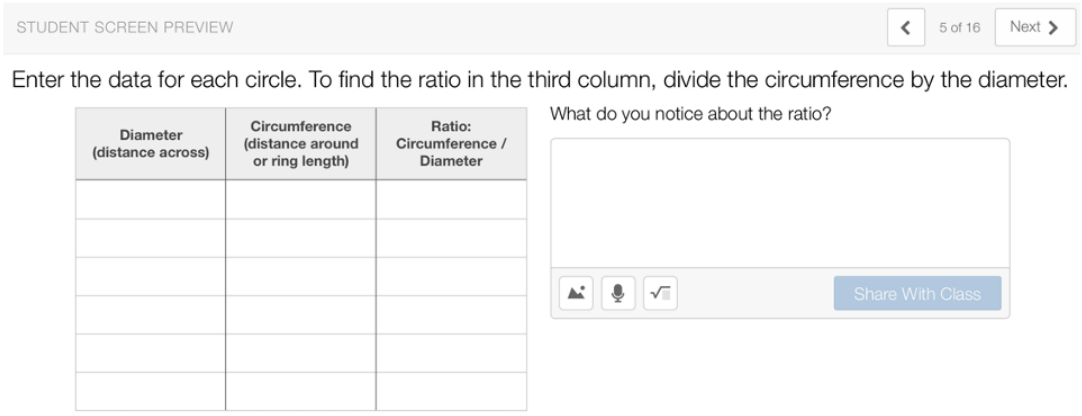

Figure 3: *A data slide from the Desmos activity for Dianne's Quill Boxes.*

After some exploration students are shown a video by another Elder who in making hand drums measures a length of wood to be bent into a ring for a drum by measuring three times across and a hand width. This helps to solidify the idea that the little bit extra must be proportional to the distance across. For bigger circles we need a hand width not a thumb width.

Students eventually are introduced to the term pi and invited to do some research on this term. They are also invited to learn more about quill boxes with links to videos and websites.

The Dianne's quill box activity is an example of how mathematics emerges when we begin in meaningful cultural contexts and allow the community knowledge to guide the learning experience. Joseph [5] has argued that ideological beliefs about European superiority meant that, in mathematics like many other fields, "The contributions of the colonized peoples were ignored or devalued as part of the rationale for subjugation and dominance." Furthermore, Gutiérrez claimed that "School mathematics curricula emphasizing terms like Pythagorean theorem and pi perpetuate a perception that mathematics was largely developed by the Greeks and other Europeans" [4]. As an educator, I would share with my students that mathematical reasoning existed in Mi'kmaw knowledge systems even if it did not get written down in textbooks. This erasure of their own ways of knowing in mathematics was a lived reality for the students I taught. Dianne did not learn about three and a thumb from school mathematics, rather she learned it from generations of quill box makers who wanted to ensure the strip would be long enough without waste. This learning is tied to a value of taking only what you need and is foundational to the Mi'kmaw notion of *netukulimk*, or harvesting sustainably to ensure there is enough for all our relations. Mathematics emerged in this context of understanding how much is enough.

Basket Making

Basket making provided another interesting connection to mathematics that was being learned in school. In a past textbook series [6] used in Nova Scotia, a unit of Math 10 focused on the geometry of packaging. This unit had students investigating the economy rate of various packages using the ratio $ER = \frac{V}{SA}$. Through a series of investigations students explore different prisms and cylinders to see which is the most economical eventually learning that a cylinder with height equal to the diameter is more efficient than a cube. This unit prompted one teacher to link this unit of work to the practice of making woven ash baskets in common in the Mi'kmaw community (see Figure 4).

Figure 4: *Mi'kmaw Ash Baskets*

Thinking that making baskets and making containers could contain similar ideas, the teacher called her auntie, a well-known basket maker in the community. "So you have a big class or a small class this year?"

the auntie asked. “Well, I have a pretty big group this year, there are 23 students in the class,” replied the teacher. “Okay,” Auntie responded, “I don’t have very many strips, but I know what we’ll do, we’ll make this one.”

The basket maker, knowing that she wanted a good-sized container but only had limited amount of strips came in and taught the students how to make a cylindrical basket where the diameter of the base was equivalent to the height. The students declared that while they had to do “all this math” she knew the answer already (See Figure 5). This became their SMYM project.

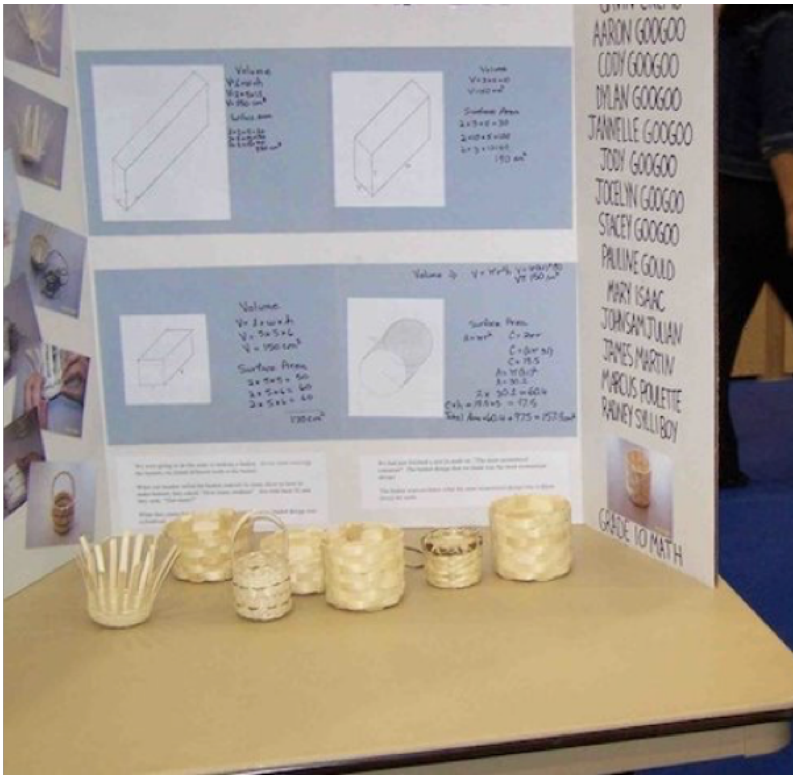

Figure 5: *Basket SMYM project.*

Similar to the quill box activity, and the drum making, basket making demonstrated that mathematical ideas emerged from Mi’kmaw values, wanting to use resources efficiently to avoid being wasteful. Such ideas have often prompted me to question how often mathematics does just the opposite and instead invites children in schools to maximize profits or find ways to extract the most resources. These ideas run contrary to Mi’kmaw value systems.

Birch Bark Biting

The idea of using birch bark biting as a SMYM project came from a discussion with Elders that actually stemmed from a discussion of the basket making project described above. One Elder shared, “When I was a young girl my mother used to peel thin strips of bark off the logs and ask us to fold them and bite shapes into them.” Naturally, my curiosity was peaked. I asked her more about this as I knew of birch bark biting that happened elsewhere in other Indigenous nations in what we now call Canada, but I had not known it was something commonly done in Mi’kma’ki. She explained that it had in fact been a common past time in her childhood, but she was not sure if anyone still was able to do it.

I took out some paper, as we had no bark available at the time, and asked her to show me how to fold the paper to do the birch bark biting. She instructed me to fold it in half, and then rotate it and fold it in half along that first fold. As I worked to line up the paper, I asked her if there was a Mi’kmaw word to describe

this process. She replied, “Yes! Tetpaikatu!” I asked, “What does that mean?” to which she told me, “Fold it the right way!” and we both laughed. She suggested that I learn more about it by doing some research and maybe students would want to learn it too. I did just that.

In my searching for information about birch bark biting I came across an article written by Oberholtzer and Smith [7], two anthropologists, who had travelled the country interviewing people who were known to be birch bark biters, each of whom believed they were one of the last people in their communities who could still do these bitings. As I read the article and came to a paragraph on the second page, I was stopped in my tracks. There was a passage about Margaret Johnson of Eskasoni, a basket maker and birch bark biter. I knew Margaret Johnson, or Dr. Granny, as she was commonly called throughout Mi’kma’ki. I knew her family, had taught some of her grandchildren at the university, and knew her sister, Caroline Gould, very well as she was an Elder and basket maker in We’kqoma’q First Nation where I had lived and worked. As I reached the bottom of the paragraph, I saw the line that stated her sister, in another community, was also a birch bark biter. I knew that must have been referring to Caroline. Unfortunately, by the time I found this article both women had passed on to the spirit world, but knowing their history with birch bark biting, we knew it was something students should learn about.

I set up a plan with a teacher in one of our Mi’kmaw schools and we decided to go work with grades 5 through 8 to teach them about birch bark biting and to try it for ourselves. We had collected some bark but knew we would need more. One of the teachers at the school contacted someone in the community who could bring us more bark. When he arrived with a great big barrel of birch bark, I asked about it. He told me he had collected it up the mountain when people were logging up there. He would go and harvest the bark. He told me that he had collected this bark years ago for Dianne, but she never got to use it. I took this as a sign we were on the right path. We figured out how to do birch bark biting by watching videos online of other birch bark biters and working together to figure it out. The students took to it instantly and found it enjoyable and engaging. We were impressed with the work that they were able to create (see Figure 6).

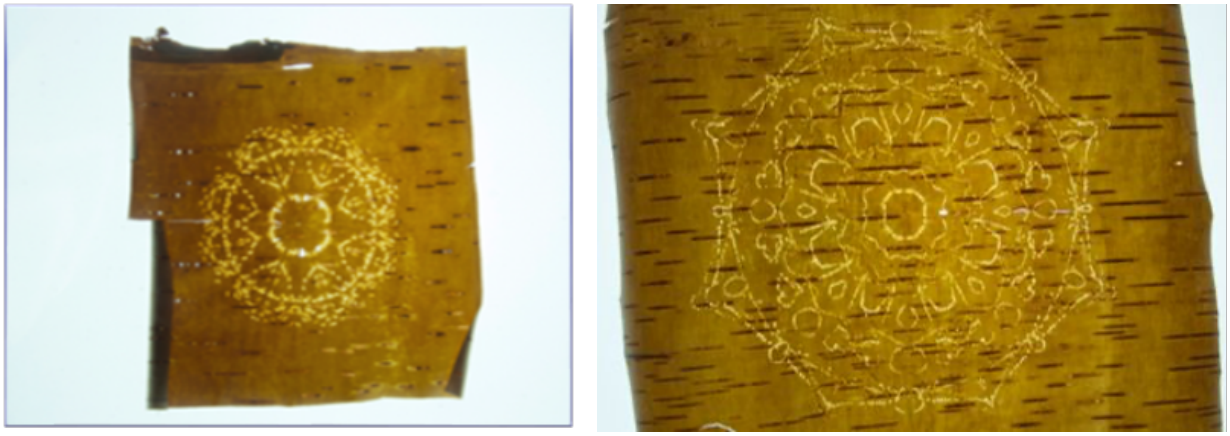

Figure 6: *Two student birch bark bitings.*

While it might be tempting to impose mathematics on the artifacts as they are depicted, where the real mathematics happens is in the creation of these images. One must really understand that a circle is a collection of points that are all equidistant from a centre to create a circle when only biting one small part of it and then unfolding the bark to create a full design. The 8-point star was also something that required significant understanding of angles to create. The student who created the 8-point star in Figure 3 (left) had worked for some time on getting it to be just right. He had to think about the angles he was employing and how the paper was folded. There is a significant focus on the role of visualization in creating birch bark bitings. We also noted that through folding the paper, students became very aware of the fractions involved and were able to easily explain halves, quarters, eighths, and sixteenths that came from folding the bark.

In addition to the mathematical thinking that was emerging from the work done with birch bark biting, students were also learning stories about the people in their communities who had done it as a practice. Stories were being told by teachers who were remembering seeing it happen as a child or hearing stories about it from Elders. Students were also learning more about birch trees and the uses of birch bark and the proper way to collect bark. Again, the learning extended far beyond the math.

Concluding Thoughts

The stories I share here are rooted in long standing relationships and communities engaging in exploring knowledge within their own cultural context. I often worry about sharing these stories outside of the Mi'kmaw community, or other Indigenous communities, as I fear that people will want to mathematize these artifacts and miss the stories and community connections from which they emerge. As mathematics educators and mathematicians attempt to respond to the calls to action of the Truth and Reconciliation Commission of Canada (2015), they might be keen to use artifacts from Indigenous communities and apply Western mathematics to create learning experiences. In our SMYM work, we do not begin with Western mathematics, rather we begin in interesting community contexts where mathematics has the possibility to emerge. As I stated in previous work with colleague Dawn Wiseman:

> *In each of our stories, the activities opened up spaces from which explorations, questions, and conversations could emerge and live for a while. When these spaces open up, what we find is important is taking the time to be with what they teach, to pay keen attention to the possibilities for teaching and learning. In this way, we see STEM as an artifact of teaching and learning, not a framework imposed upon it. [1]*

Such an approach to teaching mathematics with Indigenous knowledge systems requires that we first begin in relationships. We must work with communities and take the direction of communities, ensuring that we respect what can be shared and what must not be shared. When we begin in these ethical spaces we create opportunities for both community knowledges and Western mathematical knowledges to co-exist and come into conversation with one another [3]. Such ethical approaches can be generative when done in such a way that they are first rooted in respectful relationships.

References

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