Chapter published in:

Living Culturally Responsive Mathematics Education with/in Indigenous Communities
editors: Cynthia Nicol, Jo-Ann Archibald Q'um Q'um Xiiem, Florence Glanfield, Sandy Dawson
publisher: Brill/Sense, Leiden, The Netherlands
date: 2020
pages: xx-xx (*in press*)
online book information: *https://brill.com/view/title/55536*

Show me your Math: Mi'kmaw Community Members Explore Mathematics

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INTRODUCTION

Since 2007, in the spring of the year, Mi'kmaw students from across Nova Scotia and other parts of Atlantic Canada, have been coming together at the annual Show Me Your Math (SMYM) event to share math fair projects created to demonstrate the results of their own ethnomathematical investigations. In the initial four years of the program, participation at the math fair has ranged from three to five schools, and starting in 2011 all nine schools under the Mi'kmaw Kina'matnewey (MK) system participated, and SMYM events have been developed in other jurisdictions including Wolastoqey communities in New Brunswick, and communities in Northern Ontario and Nunavut. Currently in MK schools alone, annual participation includes 200-300 students attending math fairs and thousands of students contributing projects. In this chapter we describe the SMYM event, its origins, and its impact on participating Mi'kmaw schools. We describe the transformative potential of such ethnomathematical activity for both students and their teachers and the enthusiasm of the Mi'kmaw students who, through this work, came to see that mathematical reasoning is part of their own cultural heritage and worldview.

Drawing on positioning theory as conceptualized by the social psychology work of Harré and van Langenhove (1999) and its development in the context of mathematics education by Wagner and Herbel-Eisenmann (2009), we describe how this project is challenging traditional storylines in classrooms. We argue that SMYM is contributing to a greater sense of equity by addressing critical questions of identity and power and enabling community voices to be seen as a source of authority.

Stories from the communities and the classroom exemplify how this project is lived out in schools and communities. These stories illustrate some of the many benefits of this project and give examples of the impacts on both the students and the communities. We will conclude with strategies and suggestions for how such an event might be enacted in another community.

CONTEXT

The Mi'kmaq are Indigenous inhabitants of Atlantic Canada. These communities have a unique jurisdictional agreement with the Government of Canada, known as the Mi'kmaw Kina'matnewey (MK) agreement, which gives the MK communities control over their education system and collective bargaining power. The MK communities have a stated goal of decolonizing education

by incorporating Indigenous knowledge, culture, and values in their curricular and pedagogical practices. Such a decolonized approach to education, that allows for the inclusion of Indigenous worldviews, has been advocated as a necessity to meet the needs of Mi'kmaw students (e.g., Battiste, 1998; Battiste, 2000; Orr, Paul & Paul, 2002). Yet these communities are also responsible under the agreement to offer provincially comparable curriculum. More recently, in response to a call from the Department of Indian and Northern Affairs Canada (INAC), the communities are also expected to implement accountability measures. Thus they have begun a "school success planning" initiative. As such, participating schools are now required to write provincial assessments in mathematics and literacy. There are significant tensions for teachers who must find ways to demonstrate success related to the values embodied in provincial curriculum while centring on community knowledge, language, and values.

The marginalization of Mi'kmaw youth from mathematics is a long-standing concern in Mi'kmaw communities. While it is difficult to gather accurate statistics on the number of Mi'kmaw students pursuing educational paths involving mathematics and sciences, community leaders recognize and articulate concern about the disengagement of their students from these subjects. Similarly, interested parties within Indigenous contexts across Canada have expressed concerns about low participation in STEM fields. The government's national working group on education (Indian and Northern Affairs Canada, 2002) has said that a key area to be addressed in Indigenous education in Canada is the development of culturally relevant curricula and resources in areas of mathematics and science where there is currently an identified weakness. Although not specific to Canada, this argument is supported by a National Council of Teachers of Mathematics publication that stated that Indigenous people in North America have the lowest participation rates of all cultural groups in advanced levels of mathematics (Secada, Hankes & Fast, 2002).

Ezeife (2003), Secada, Hankes, and Fast (2002) and others have identified a key reason for the disengagement of Indigenous youth from mathematics and science – the discrepancy between their own cultures and the cultural values embedded in school-based mathematics programs. Cajete (1994) found that when science is taught from a Western cultural perspective it acts in opposition to the values of traditional culture for Indigenous students, which affects their performance in mathematics and science because it simply is not connected to their daily lives. Similarly, Lunney Borden (2010) has shown that the lack of attention to value differences and the use of inappropriate pedagogical strategies are among the factors that disconnect school-based mathematics from Mi'kmaw ways of reasoning mathematically.

As a result of value differences, many children choose to opt out of mathematics because the cost of participation is too high, demanding 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 Indigenous students and Gutiérrez (2012) has raised the same issue for minority groups in general. The incidence of conflicting world-views has led many Indigenous students to either ignore the possibility of studying science or mathematics or to struggle within these disciplines. This marginalization is a serious issue for Indigenous communities that look to younger generations to acquire the skills and knowledge needed to move their communities closer to the realities of self-government in this modern age.

CONCEPTUALIZING CULTURALLY RESPONSIVE MATHEMATICS

Before sharing stories from SMYM, we situate this work within the broader field of culturally responsive mathematics education. We believe that SMYM presents a decolonized approach to mathematics learning and embraces many aspects of culturally responsive education advocated for

by researchers in areas of Indigenous education, ethnomathematics, and equity. These we will be outlined in this section.

Inequities and marginalization in mathematics education can be addressed through a decolonized approach. A dominant theme in the literature is that Indigenous education should seek "to heal and transcend the effects of colonization" (Cajete, 2000, p.181). Hampton (1995) argued that Indigenous education cannot ignore the reality of colonization but rather must address the issue directly. Indigenous education needs to move towards decolonization which can be seen as a process of "deconstruction and reconstruction" (Battiste, 2004) that "engages with imperialism and colonialism at multiple levels" (Smith, 1999, p. 20). This demands the critical examination of the hegemonic structures of mainstream education that continue to perpetuate the values of colonialism (Battiste, 2004).

The quest for greater cultural relevance in the teaching of mathematics has resulted in many projects that have attempted to document the cultural mathematical knowledge within Indigenous communities of North America (Barta et al., 2001; Lipka, 2002; Lipka, Wildfeuer, Wahlberg, George & Ezran, 2001; Poirier, 2007). However, this documentation of cultural mathematical knowledge (known as ethnomathematics) is more extensive in Brazil and Africa (Powell & Frankenstein, 1997). While such scholarship often describes Indigenous understandings, it only occasionally provides substantive help toward designing innovative and sustainable curricula. Furthermore, it often fails to guide teachers' pedagogical practice in response to the impacts of colonizing curricula.

Some applied research has treated Indigenous knowledge of mathematics as add-ons to non-Indigenous curricula, as in basket and beadwork patterning (see Secada et al., 2002). Doolittle (2006) has argued that this can lead to an oversimplification of complex ideas, which he referred to as the "cone on the range"—the complexity of a tipi is reduced to an example of a cone. Such trivialization does not honour the knowledge or learning needs of Indigenous students nor does it promote substantive change in teaching practice.

The *Math in a Cultural Context* series published by the University of Alaska, Fairbanks stands out as the result of an exceptional project that has provided both learning resources and teacher supports. This Alaskan initiative, ongoing for over 25 years (Lipka, 1994: Lipka & Adams, 2004; Lipka, Mohatt, & The Ciulistet Group, 1998; Lipka et al., 2001), has brought together Yup'ik teachers, elders and university faculty as a research group to develop culturally based mathematics. The project originally began with the Ciulistet group which was a voluntary group of elders and teachers, many of whom travelled significant distances for meetings, which Lipka has claimed was a testament to their desire to improve education for Yup'ik children. Although this group is no longer involved in the research, the work of transforming mathematics education in these Yup'ik communities has continued.

The university researchers worked collaboratively with community members, relying heavily on the elders, to deepen their understanding of Yup'ik mathematical and scientific knowledge. The group chose the research focus, and the knowledge they gathered allowed them to develop lesson units that could be implemented in school. The process of translating this Indigenous knowledge into formal curriculum was difficult and required extensive support from the elders. The group developed units and took them to the elders who then debated the details and gave feedback. The group then recreated the units and brought them back to the elders. The process began again until a satisfactory product was produced. Lipka (1994, p. 25) stated that:

> The premise behind developing a Yup'ik mathematics is threefold: (1) to show students that mathematics is socially constructed; (2) to engage students in a

process of constructing a system of mathematics based on their cultural knowledge; and (3) to connect students' knowledge of "their mathematics" through comparisons and bridges to other Indigenous and Western systems.

This threefold approach is central to Lipka's "both/and" notion of transforming curriculum. The MCC experience was very influential in the evolution of SMYM. We believe that substantive change in mathematics education will happen when Indigenous knowledge and community worldviews are given a position of privilege alongside traditional school-based views of mathematics. Decolonization is not about valuing one way of knowing over another, but rather about valuing multiple worldviews for their contributions to each other. As we show below, SMYM is an event that provides a space for such valuing, inviting Mi'kmaw students and their teachers to explore and value the mathematical ways of knowing within their own community context.

We believe the structure of SMYM also incorporates many aspects of culturally-based pedagogy for Indigenous students. Cappon (2008) argued that Indigenous education holds the view that learning is holistic, lifelong, experiential, rooted in Indigenous languages and cultures, and spiritually oriented. He claimed that it is a communal activity with all community members playing a role and that it integrates both Western and Indigenous knowledge. Orr, Paul and Paul (2002) have shown how this notion of bridging Indigenous knowledge with mainstream curriculum has been worked at effectively by Mi'kmaw teachers in one of the participant communities. These teachers provided a quality education through the incorporation of cultural practical knowledge along with Indigenous pedagogical, relational, and political consciousness.

Lunney Borden (2010) examined calls for transforming mathematics education with two schools participating in SMYM. Through on-going discussions in the form of *mawikinutimatimk* (coming together to learn together) the participants in her study highlighted areas of tension that, she argues, must be addressed in order to transform mathematics education for Mi'kmaw learners. These areas include: 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. Within each of these categories, teachers identified conflicts that arise when worldviews collide and identified potential strategies to address these tensions. SMYM was often pointed to by participants as an approach that addresses many of these areas.

Through a decolonized approach that is responsive to the calls for transformation from Indigenous communities, which are increasingly reflected by settler neighbours (e.g., uptake on the calls to action from the Truth and Reconciliation Commission of Canada (2015)), SMYM brings about a greater sense of equity for Mi'kmaw students. Although equity may be interpreted differently in different contexts, it is often focused on addressing disparity among various groups by improving access to quality mathematics and improving the achievement of students who have historically been marginalized by school mathematics. Our work embraces a broader conception of equity, as outlined by Gutiérrez (2012) who argued that equity should be defined in four dimensions: access, achievement, identity, and power. While access and achievement are important components of equity, the more critical concepts of identity and power must also be addressed to ensure true equity is enacted.

Gutiérrez (2012) has argued that many students have been marginalized by mathematics because they are asked to deny their identity in order to participate in the dominant view of mathematics. For Gutiérrez, "students should be able to become better persons in their own eyes, not just in the

eyes of others" (p. 19). She argued that ethnomathematics and culturally relevant mathematics provide the opportunity to address issues of identity within mathematics education. She described identity through a window/mirror metaphor, claiming that "students need to have opportunities to see themselves in the curriculum (mirror) as well as have a view onto a broader world (window)" (p .19-20).

Gutiérrez (2012) has argued that attention to identity does not have a goal of replacing "traditional" mathematics with a pre-defined "culturally relevant mathematics," but rather to strike a balance between the number of windows and mirrors provided to any given student in his/her math career" (p. 20). However, she also argued (p. 20) that:

> [E]ven if students have access to quality mathematics, achieve a high standard of academic outcomes as defined by the status quo, and have opportunities to 'be themselves and better themselves' while doing mathematics, it is not enough to call it equity if mathematics as a field and/or our relationships on this planet do not change. As such, a final piece of equity involves *Power*. The Power dimension takes up issues of social transformation at many levels.

The power dimension involves not only questioning who has power in the classroom in terms of who participates, who talks, and so on, but also as it pertains to using mathematics to question power relationships in the world and seeing mathematics as a human endeavour.

In this project we consider power in the context of authority. Where are the voices of authority in mathematics education? Typically, a student might see the textbook, the teacher, and the field of mathematics as being the authorities; those who define what mathematics should be learned and what counts as mathematical reasoning. There are other sources of authority at work for students though many of them may be marginalized. Amit and Fried (2005) referred to the multiple sources of authority as 'networks of authority.' However, Herbel-Eisenmann and Wagner (2010) showed how mathematics classrooms generally authorize a single authority (the discipline of mathematics present and mediated by the teacher), not the multiple sources that would be possible. We will demonstrate that SMYM challenges dominant, discipline-focused conceptions of authority by revitalizing old storylines in which elders, community leaders, parents, grandparents, crafts people, and so on are positioned as authorities, now in the context of developing mathematical understandings.

RESPECTFUL POSITIONING

The application of positioning theory was instrumental in the development of our research choices in Mi'kmaw communities. This theoretical perspective on positioning follows from an edited book (Harré & van Langenhove, 1999) and an elaboration of the theory in the context of mathematics education (Wagner & Herbel-Eisenmann, 2009). In general, *positioning* is taken to refer to the way people use action and speech to arrange social structures. Words and actions evoke images of known storylines and positions within those stories. When one person engages a storyline, others may comply with this positioning or resist it.

Davies and Harré (1999) explained how positioning theory draws attention to 'immanent' practices, as opposed to 'transcendent' discourse structures (e.g. a student's relationship to the transcendent discipline of mathematics), which Wagner and Herbel-Eisenmann (2009) showed to be a common scholarly focus in mathematics education (e.g., Evans, 2000). With positioning theory's attention to immanent relationships, aspects of human interaction become more noticeable because the larger discourses are ignored, even characterized by Davies and Harré as myths. Wagner and Herbel-Eisenmann, however, maintained the promotion of attention to immanent

practice without relegating larger discourses as inconsequential. This is because people take discourses as being real in their own right and thus powerful in immanent interactions. Wagner and Herbel-Eisenmann argued against stripping mathematics of its power (de-mythologizing it) in favour of inviting new mathematical narratives that recognize mathematics in places that it has often been ignored or marginalized (re-mythologizing mathematics). This informed our expressed desire to seek strategies to privilege Mi'kmaw mathematical knowledge and bring it alongside school-based mathematics.

THE EMERGENCE OF SHOW ME YOUR MATH

The research began with Lunney Borden and Wagner interviewing elders in Mi'kmaw communities to identify some of their everyday practices (both traditional and current) that could be deemed mathematical. This typical approach to ethnomathematics research (cf. Powell and Frankenstein, 1997) relies on Bishop's (1988) articulation of activities that are potentially mathematical (practices that involve counting, measuring, locating, designing, playing or explaining) and on the assumption that any mathematics is an artefact of a particular culture.

As we will describe in this chapter, the SMYM event emerged from these initial conversations. SMYM was certainly part of the research project which began with the conversations with elders, but this event belonged to the community more than it did to the project. Data in the project includes recordings (and transcriptions) of the interviews with elders and of the conversations in which SMYM was organized. The SMYM event generated publicly accessible student work, which gives us insight into the impact of the SMYM event. We also have listened to accounts from teachers and participant students about their involvement, but most of these were not recorded because they emerged in unexpected situations.

The larger project was initiated by David Wagner, who was joined by Lisa Lunney Borden virtually at the beginning. She had had a ten-year teaching career in one of the participant schools before beginning her doctoral studies with Wagner as her supervisor. Newell Johnson is a teacher in a different participant school, had a history of collaboration with Lunney Borden, was one of the teachers who participated in the initial meeting about SMYM, and has been a leader in its success. In this chapter we refer to individual authors in the third person at times to clarify unique involvement or voice that is not shared among the three of us. In particular, Johnson's voice is important as she shares her personal experiences with the SMYM event and associated classroom experiences, and it is necessary to clarify aspects of the SMYM story that involved Lunney Borden and Wagner but not Johnson.

Lunney Borden and Wagner were excited to hear the stories the elders were sharing with them in the early stages of the research project. However, in reflection, they saw themselves as mediators, interfering with the intended process of connecting students to the mathematics in their communities. As researchers, they were careful to orient their conversations with participants around mutual respect, yet still found connections with colonialist storylines as they observed that some participants were trying to be helpful by telling them what they wanted to know. While this spirit of cooperation seemed to be generative for the planned research, it was disturbing to have participants ask if they were telling Lunney Borden and Wagner what they wanted to hear. As researchers, they did not want to be seen as the ultimate audience but they often felt positioned in that way. It is important to recognize that Lunney Borden and Wagner were complicit in this positioning; it was not a matter of the elders and knowledge keepers choosing this relationship for them against their will. Lunney Borden and Wagner also worried about authenticity because participants seemed to be subjecting themselves to their agenda. They wanted to hear more about the participants' agendas.

The interpersonal relationships appeared to be similar to the diagram in Figure 1. The community experts were responding to researchers' requests for information to pass on to teachers who in turn would pass it on to the children. The children would then do something called 'work' for the teachers. The path of communication is quite linear passing through people less central to the communities. Lunney Borden and Wagner, as researchers, had some involvement in the community (and Lunney Borden had further involvement unrelated to research). Some of the teachers lived outside the community but even the teachers who lived in the communities and were Mi'kmaq (including Johnson) were connected to and associated with curricular demands that came from outside the community. This is why we have the researchers and teachers straddling the boundary of the community in the diagram.

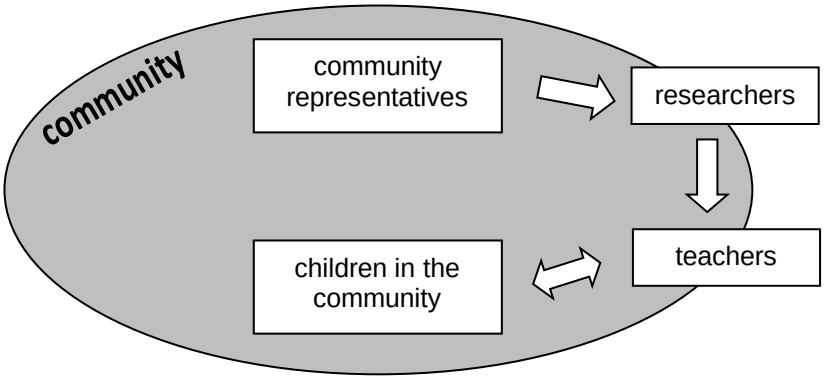

Figure 1. Interpersonal positioning in the initial ethnomathematical work.

New storylines were necessary. Attending to positioning opened up new opportunities. Lunney Borden and Wagner realized that the conversations would be more authentic if the children themselves talked with elders and others to find mathematics in traditional and modern community practices. They, as researchers, needed to remove themselves and the teachers from the position of mediums. Also, reflecting on Morgan's (1998) research that underscores the importance of audience in students' mathematical writing, they realized that positioning the children as the ultimate audience in the ethnomathematics conversation does not afford them opportunities to address an audience other than their teacher, nor an imperative to engage in real problems/issues faced by their community.

As a result, Lunney Borden and Wagner initiated a new series of conversations structured to prompt community members to talk and listen to each other about everyday mathematics in traditional and modern community settings. From their dissatisfaction emerged the "Show Me Your Math" (SMYM) event that changed the interpersonal positioning in substantive ways.

Lunney Borden and Wagner approached some schools with the idea for a SMYM contest and invited teachers (one of whom was Johnson) to come to a meeting to discuss this possibility. They imagined an event in which students would be invited to do projects exploring the mathematics in their everyday lives. They planned to have students submit their work to a website that would be hosted by the Atlantic Canada First Nation Help Desk, an existing infrastructure that supports communication amongst communities via the internet. Such 'contests' are commonly used in this region to promote community-based education and to develop cultural resources for teachers and

students. While this plan was well received, Johnson and the other teachers in the initial meeting wanted more than a website. They suggested that schools host local mathematics fairs and send selected students to a regional fair where they could share their work with others.

To substantiate the break from the school tradition of students doing work for teachers as audience, it was suggested that instructions for the contest be given in a video. The teachers in the workshop contributed to the structuring of the video, but the researchers produced it. It featured Indigenous people, including an elder, a middle-aged teacher, and children, all asking the viewer (the student) to show their math (their community's math). We all felt that the form of this video would help students see the community as their audience instead of their teachers. In response to this prompt, school children interviewed elders, experts in crafts, and others to explore mathematics done in their communities in historic and modern times. They published their work on an internet site hosted by the Atlantic Canada First Nation Help Desk and also presented their work to the region's communities in a math fair. (Selected student projects are now available at http://showmeyourmath.ca.)

The interpersonal relationships structured with the SMYM event are more complex than the relationships in the initial research configuration. Figure 2 illustrates an attempt to diagram these relationships. The three of us (Lunney Borden and Wagner as researchers and Johnson as a lead organizer) were and continue to be in conversation with other teachers (and some other community representatives, including elders). These conversations initiate student investigations that involve students in conversation with experts in the community. The students report back to the community, to their teachers and to the researchers at mathematics fairs and also to the outside world because some of their work is made available online. In our view, the most important difference between this set of relationships and the earlier one is the communication between children and others in the community, illustrated by the big bidirectional arrow in the middle.

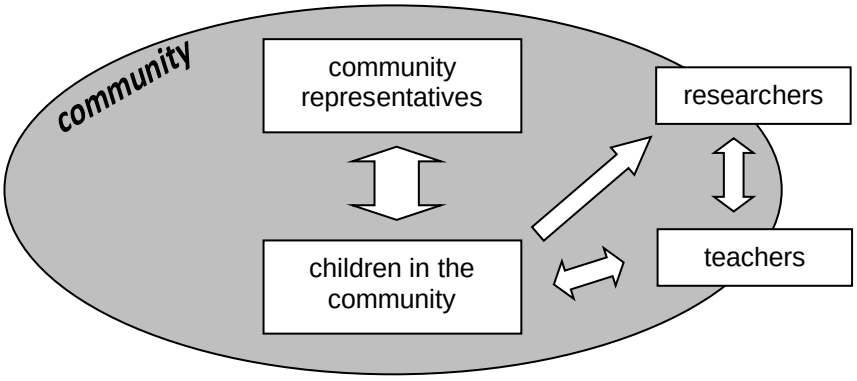

Figure 2. Interpersonal positioning with the "Show Me Your Math" event.

Wagner and Lunney Borden (2012) elaborated on these shifting positioning structures and associated storylines, and on the power of positioning theory for interrogating relational practice. This chapter has a different focus. We draw upon examples of student work and stories from participants in the SMYM event to demonstrate how this project is transforming mathematics education in participant schools and contributing to a more culturally responsive mathematics program. With the community positioned as the source of mathematical authority and the students positioned as researchers and disseminators of mathematical knowledge, this project has created

an opportunity to realize Wagner and Herbel-Eisenmann's (2009) imperative. It opened up the opportunity for students, teachers and community members to "identif[y] with storylines that are not traditionally a part of mathematics classroom discourse" (p. 13). These new storylines have challenged traditional conceptions of authority and transformed the relationship between students and mathematics as a field of study. In the next section we will share stories that illustrate how SMYM has achieved greater equity through attention to these questions.

DEVELOPING NEW STORYLINES: SEEING THE COMMUNITY AS A SOURCE OF AUTHORITY

The nature of this project was that children were encouraged to learn in relationship with community members, family members, elders, and peers. Such communal activity invites all community members into the conversation about mathematics. This kind of learning promotes respect for community knowledge among students. It helps them to see that mathematical reasoning is a part of their own cultural identity. It also positions the community as a source of mathematical knowledge thus dispelling the myth that mathematical knowledge comes from teachers and textbooks. In this section we share stories from the project that exemplify how students have learned from the community.

A common experience for students involved learning from elders, in particular parents and grandparents. The following story comes from Johnson's observations of her nephew engaging with his grandparents (Johnson's parents) as he was working on his project. This exemplifies the kind of family involvement that has been prompted by the Show Me Your Math event:

> Sitting around the kitchen table at my parents' place, a place that I visit every day after work, I was listening to a conversation between my father and my eight-year-old nephew. My nephew had just informed my father that he had to do a project for Show Me Your Math, and that he knew what he wanted to do.
>
> He reminded my father about the hide that my parents had prepared over the summer. After recounting those memories, my nephew asked my father if he did anything with the hide. My father told him about the beautiful drum that was created from that piece. My nephew then asked him if he had to use any math to figure out the measurements, and my father's eyes opened wide. If my father were any younger, he would have been jumping up and down with excitement. My father explained to him that he had to cut out circles from the hide, bigger than the drum top and he further explained to him why they had to be measured that way.
>
> My nephew told my father that he wanted to do a project on the hide and he wanted my father to show him how he could measure pieces to make the drums. My father asked him if he was serious, and even tempted him to do a project on something else, something else that my father thought the teachers would appreciate. But my nephew was adamant in his decision. He insisted that he wanted to do this project and he wanted to see how he could measure the hide to make drums.
>
> As I was listening, I was really surprised, and my mother was becoming more and more excited at the thought of my nephew taking such a keen interest. After some time into the conversation, my father turned to me and asked if I had anything to do with this, and as I smiled I said "No." He gave me that look, that look of knowing that I was really enjoying the events as they were unfolding.

> My nephew was brainstorming on how he could make circles on his hide that was now drawn on paper, and he began hunting for objects that were circular. He found some milk covers and some larger juice covers. In all, he found three different sizes and he began to trace them on his paper. He noted that he needed two of each, one for the top of the drum and one for the bottom of the drum. He made some measurements of the circles and drew some circles on the side of his poster. He was able to count how many different size drums that this piece of hide would make. He had arbitrarily given the covers a diameter measure of 12, 24 and 36 inches.
>
> After completing this task, he remembered that there was a picture on the computer of my parents standing beside the hide while working on it. He went to the computer and found the picture, printed it off and glued it onto his poster. He was so proud of his project. Being a math teacher, I was the proudest auntie on that day. My parents were also proud and were amused by the fact that I was in my glory and was so thrilled at the enthusiasm, creativity and determination that my nephew had brought into the completion of his Show Me Your Math project.

We see the shift from the traditional expectation that mathematics is learned in mathematics class. In this case, the mathematical discussions are occurring between a boy and his grandfather and are stemming from an out-of-school experience. We see that this project is one that is of interest to the child and stems from his own curiosity. His problem is not one that has been assigned by a teacher or a textbook, but rather has emerged from his own desire to understand one of his experiences. We note the grandfather's resistance to this shifting storyline in his suggestion that the child do something that the teachers might prefer. This exemplifies the deep-rooted nature of the belief that mathematics is of the school and not of the community. This is reminiscent of earlier ethnomathematical conversations with elders in this project who drew distinctions between school-based mathematics and community mathematical reasoning (this distinction is elaborated in Wagner and Lunney Borden, 2015). These elders, like the grandfather in this story, did not see their knowledge as something that would be valued by the school, they did however, make the argument that learning community ways of reasoning would benefit students' common sense.

We also see our plans for changing the sense of audience being played out in this episode. The boy seems well aware that he will share this knowledge with peers, teachers and the community. His school holds a local math fair in advance of the regional math fair. His attention to detail and inclusion of the picture of his grandparents next to the hide, demonstrate his desire to celebrate his grandparents' knowledge and to share this with his peers. This also demonstrates how the community knowledge is re-positioned and given high priority in this project. This knowledge is not an add-on or a tangential connection to the privileged mathematics, rather it is given a central focus with the mathematics emerging alongside the community knowledge.

This second example comprises Johnson's reflections on a teaching experience. It exemplifies how students' needs and interests are at the centre of SMYM projects. In her classroom, participation in the SMYM project is something that the students know is an expectation for the course. It addresses the major outcomes for an independent research unit in the grade 11 mathematics curriculum prescribed by the province and used by the community schools. The story relates to a project done by two sisters who wanted to honour the memory of their mother.

> There were these sisters that were in my class, and they had just recently lost their mother to a fatal heart attack. Their mother was taking a course in Ontario over the summer, and prior to her coming home nearing the completion of her course, she

> had suffered a massive heart attack. This mother was younger than me and the community was in shock. She left behind a husband and five beautiful children. At the beginning of the school year when I announced in class that students will be doing this project and explained to them that it would have to be something related to our culture, the girls casually called me to their desk, and asked if they could do a project on moccasins. I was really excited and anticipated their creative thinking. I asked if this is something that they knew how to do, and they looked to me with sadness. I sat down beside them and asked them what was wrong. They explained to me that their mother was doing a course in Ontario where she was learning to make moccasins. She was training to be a leather artisan and moccasins were her specialty. A few weeks before her course completion, she had died alone in her dorm, being away from her family for almost the entire summer.
>
> They wanted to know what their mother's passion was and they were inspired by the thought of having the opportunity to bring this into the classroom. They completed their project, bringing in some of their mother's tools and actual moccasins that their own mother had created. They stated at the end of the project that their mother had to know a lot of math in order to be able to create moccasins. I was very happy that the girls had the opportunity to explore their mother's work and to bring pride and understanding to her passion.

This story highlights how participation in SMYM can allow students a space to explore something that is important and meaningful to them. These students saw this project as an opportunity to celebrate their mother and to learn more about her craft. Also, in sharing their learning with peers, teachers, and the community, these young women had an opportunity to celebrate their mother's talents and her life. This story and other experiences like it remind Johnson that her role as a teacher is constantly changing including the need to be a provider of information, a facilitator, a guide, and a learner.

This recognition of the teacher's role as learner is juxtaposed with a typical mathematics class interaction structure, which involves teachers asking questions for which they already know the answers. With SMYM the students are not completing tasks that have a clearly defined process and solution; rather, they are using their understanding of mathematical concepts and their own community knowledge to create new mathematical knowledge. These students are now positioned as the experts, the researchers who have discovered something that can be shared. The teacher can then be seen as a legitimate audience as she does not already know about the content of the projects. As such the students are engaged in authentic mathematical investigations with an expectation that they will have an authentic audience who will see them as experts in their chosen project.

Student interests are often the focus of mathematics learning that occurs as a part of SMYM. "The Mi'kmaw star" is a well-known design amongst Mi'kmaw people (see Figure 3). The shape is often coloured using the four traditional colours of red, black, white and yellow, each having spiritual significance. This star shape has been the subject of several SMYM investigations.

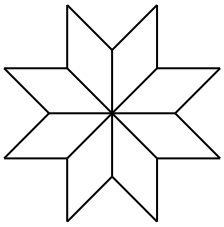

Figure 3. 8-point Mi'kmaw star.

In the first year of SMYM, one high school student (Johnson's daughter) chose to explore aspects of paper folding and cutting that would enable her to quickly create an eight-point star. Through a series of explorations she developed an approach that involved three folds and one cut, creating a perfect star. This project came from her own unique explorations. Having seen that paper folding and cutting can be useful in geometric reasoning she chose to apply this strategy to something of interest to her. During the math fair she shared with those in attendance her stories of discovery and also invited visitors to try it out for themselves with her guidance. Figure 4 shows her doing this folding.

During a more recent SMYM fair, two grade 12 students explored geometry involved in making a somewhat more complicated 8-point star design often used in beadwork patterns and quilting patterns. They used their school-based geometry to create the design with intricately detailed borders but they also spoke about elders in their community who were skilled at using these designs for beadwork and quilts. These students concluded that using the mathematics they learned in school was far more complicated than the elders' way of making a similar design. One of the girls explained:

> We were just saying how it's cool how our ancestors and our elders can make these stars without using geometry. It's all proportioned correctly without geometry. They don't need all these steps, they just do it on their own. […] A lot of our elders use them still, in quilts and stuff like that. To them it's normal because they already know.

In this example we see that students are responding to and thus transforming their relationship with school-based mathematics by making connections with community practices. The students recognized that the textbook approach provided one way of looking at geometric construction, but equally valued their elders' knowledge. In this example, the degree of interaction between the students and the elders does not seem to be fully evident: the student seemed to refer to the elders symbolically as representatives of the whole community. As far as we know, the girl quoted above did not interact with elders in her project work, but rather reflected on things she saw in her community. This resembles a form of learning traditional to Mi'kmaw people – observing in silence.

Figure 4. Folding the 8-point star

The students referred to the elders as possessing this knowledge and not needing to do all the mathematics. However, when prompted as to how they thought these elders did this work, the students replied that they did not know and admitted that they "should have asked them that." This is not intended as a critique of the students' project but points to a way in which this experience could have been enhanced for these students, and perhaps for the elders as well. That being said, we see again that SMYM investigations encourage students to think critically about a textbook's authority and to examine how community knowledge can be equally privileged.

These few examples of student work and interactions give a snapshot of how traditional storylines in mathematics classes are changing as a result of SMYM. In each example we see how community knowledge is celebrated and given a place of privilege alongside of traditional school knowledge, thus enabling students to see how mathematical reasoning is a part of their own cultural heritage. We also see the important role of authentic engagement in mathematical investigations that address students' interests and needs. In each case students were able to choose a project that was meaningful to them, to conduct an investigation where the results were not already known by the teacher, and to be positioned as the researcher and expert in this area.

The role of audience is significant in each project. Students were aware that they would be the experts in relation to their chosen projects, they also were aware that there would be an audience that included their classmates and peers as well as other students, teachers and community members. Being asked to share their work with a wider audience gives greater purpose to the task. Each of these pieces contributes to transformation as students enter into a new relationship with the field of mathematics. In the next section we will describe some of the impacts such transformation is having in classrooms.

TRANSFORMING CLASSROOMS

Many teachers who have had students participate in SMYM have remarked about the benefits of such participation. Lunney Borden (2010) heard many positive comments about this project during her research discussions with teachers in two schools, with one teacher remarking that this type of learning is what is needed more often to help students make more meaningful connections to mathematics on a daily basis. The SMYM math fair is a highly regarded and much celebrated event each year within the Mi'kmaw schools and each year more participants contribute projects. Many teachers have shared with us how great the impact has been on their schools. We have ourselves often been overwhelmed by the enthusiasm and excitement in students' voices as they share with others the ideas they have learned. In this section, we share Johnson's stories of how this project is impacting her classroom. We feel her experiences are representative of the transformative potential of SMYM.

Even before the SMYM event started, many teachers in MK schools, like Johnson and Lunney Borden prior to 2005, searched for ways of representing and explaining mathematics to make it more comprehensible for their students and more in line with students' ways of thinking, especially as this relates to the concepts, preconceptions and misconceptions students bring to the learning of mathematics. Many MK teachers, in particular those like Johnson who grew up in the communities, often looked to her own cultural practical knowledge and searched for any information that could be used to further enhance methods of representing and explaining concepts. She sees the SMYM event as one clear way to invite students to look at their culture and derive mathematical concepts and representations. The students' investigations help their teachers expand their repertoires for connecting mathematics with cultural practices. Johnson and other teachers have remarked that they find it interesting to see what the students bring to the learning and how their mathematical learning is evolving and emerging. There have been many Show Me Your Math fairs and numerous projects done by students in the early grades, and parents and teachers will still continue to remark that they are amazed by the mathematical content knowledge that the students bring into their own learning.

Johnson has noted that in her own mathematics classroom, she is constantly looking for engaging activities that also develop students' mathematical concepts. She has often developed activities where students are invited to learn outside of the classroom, yet this has been met with criticism. For example, other educators have told Johnson she is giving students free time and that

they are not engaged in learning. Johnson has observed that on the contrary, students are often more engaged than if they were to learn from a textbook using conventional methods. She has found that Mi'kmaw students are more inclined to be motivated if they are given the opportunity to create, explain, and investigate on their own terms, in their own language, and in their own realm of knowing and constructing.

It is often difficult to advocate this type of learning in the high school, where there are specific curriculum outcomes that students must achieve, exams to prepare for, and assignments that require completion. However, Johnson continues to create activities where all these domains are addressed through activities designed to foster more culturally relevant learning environments. She notes that this is quite challenging; however, as the years pass, she is finding it easier to draw from her own cultural experiences and those in the students' SMYM projects to challenge the taken-for-granted assumptions in the curriculum. This does not mean ignoring the curriculum guide, but rather finding activities that are more project-based and culturally relevant like those done for SMYM.

She has seen the benefits of such activities during her peer mathematics tutoring sessions. The peer tutors often create math centres and activities to engage their learners. Johnson finds it amazing to watch students take so much interest in attempting to reach struggling learners, and the motivation that drives them is inspiring. She often draws from the experiences with this group, inspired to create engaging, culturally relevant activities that the tutors can pilot during these peer-tutoring sessions.

Johnson believes that when her students are involved in ethnomathematics, and learning mathematics related to their culture, it cultivates their cultural identity. The SMYM projects allow the students to develop their own learning, to select topics that interest them, and to present their projects in meaningful ways that address their own learning styles. This type of activity allows students to arrive at a solution in more ways than one, where a hands-on approach to learning is often the method of choice. This form of project-based learning has proven to be an effective method of teaching for her. Each year, all of her students submit projects for both semesters, something seen as uncommon at the high school level. It was surprising to the staff and principal. The principal asked Johnson, "How do you get them to do their projects, to pass them in on time, and to get all the students to do one?" She had no real answer at the time; however, after reflection on this question, she felt that the students took ownership of their own learning. They chose topics that interested them, and used their own culture as the basis for their projects.

Johnson also notes that her repertoire of activities has increased since she initiated the SMYM projects as a part of her classroom routine. She has accumulated many projects over the years, and with the students' permission, she includes their projects in her lessons whenever possible. One example of this involved a lesson on quadratics. There was a project that had been submitted by grade 11 students in the previous semester on this very topic. She brought out the project and displayed it in the classroom. She told the students to have a look at it and to see what connections they could make from the project and what they were learning. As such, Johnson noticed a connection with Tompkins (2002), who wrote, "I see my role as a facilitator as one of trying to set up structures that will acknowledge the differential power in the room and create maximum opportunities for the marginalized voices to be heard" (p. 418).

Johnson reflects, that like many teachers she often wonders, "How do I get my students to engage in critical thinking and in what context?" She has noted that SMYM has been one of the ways that she has been able to deal with these questions. She believes her fundamental obligation as an educator is to encourage students to acquire knowledge with their own eyes and not through

the eyes of others, and to hear with their own ears and not through the ears of others. The best way to do this is to take on projects where students investigate their own truth.

Bishop (1990) demonstrated this concept stating that Western mathematics is one of the most powerful weapons in the imposition of Western culture. He argued that Western ideas of length, area, volume, weight, time and money would have been imposed on Indigenous societies. These concepts were imposed because there was a need to assimilate cultures in order for the advancement of European trade. Bishop (1990, p. 57) also stated that:

> [To] decontextualise, in order to be able to generalize, is at the heart of western mathematics and science; but if your culture encourages you to believe, instead, that everything belongs and exists in its relationship with everything else, then removing it from its context makes it literally meaningless.

Removing the context of mathematics and teaching abstracted concepts in isolation is meaningless for students. The SMYM projects that the students are encouraged to do allow them to study mathematics in its context.

We believe that the purpose of education is to activate potential, rather than just retrieve and dispense facts. Students need to be given opportunities where they can explore and develop their own thinking, their own beliefs and their own understandings. They need the opportunity to make meaningful connections between their learning and their own cultural identity and experiences. The SMYM projects have allowed Johnson to understand where her students are coming from, what they can bring into the classroom, and have created a space where their voices are heard. We believe that the implementation of this type of program in the Mi'kmaw education system will continue to foster a learning environment that will allow students to reach their maximum potential.

CHALLENGES AND NEXT STEPS

While SMYM has brought about positive impacts on schools, we acknowledge that there are areas where these projects could be improved and enhanced. One key area of ongoing investigation in this project involves exploring strategies to strengthen connections between SMYM projects and prescribed curriculum outcomes. In particular, we would like to bring together elders, teachers, mathematics education researchers, and perhaps mathematicians to make the mathematical connections more explicit. Johnson expressed her own challenges with connecting project ideas to the required curriculum, and although she has found more ways to make these connections more authentic with each year of SMYM projects, she and other teachers have expressed that it would be beneficial to be supported in this area.

In an effort to address this concern, Lunney Borden has worked with many MK schools and public schools to do inquiry projects for SMYM (Lunney Borden & Wiseman, 2016) and these projects have been shared in a new section of the website called *Mawkina'masultinej* meaning "Let's learn together!" (http://showmeyourmath.ca/mawkinamasultinej-lets-learn-together/) Projects have focused on birch bark biting (Lunney Borden, 2015), paddle making, maple syrup making, eels, drum making, baskets, beadwork and so on with each project beginning in a community context and allowing mathematics to emerge. Teachers have remarked that this approach is helping them to better address curriculum pressures. One grade 5/6 teacher remarked "We can meet more outcomes than you can possibly imagine…" (MK Teacher, June 2015) and explained how much easier it was to address curriculum outcomes by teaching in this way rather than trying to fit outcomes into isolated courses. This approach shows great promise for addressing curriculum concerns, though there is an on-going need for financial resources and professional learning to continue this work.

Additionally, we have the goal of eventually using student projects and the inquiry projects to develop mathematics modules that could be used to support mathematics learning in Mi'kmaw classrooms. We see this as an important next step that may also address the need for more explicit connections to curriculum. Such modules would also enable the spirit of SMYM to impact classrooms on a more regular basis, rather than just an annual affair.

RECOMMENDATIONS

We believe that the structure of SMYM is something that may be of benefit to any community that seeks to challenge the dominant storylines in their mathematics program and to allow students to re-mythologize mathematics from their own community perspective. There were several factors that we believe have contributed to the success of this project. First, it was important that there was buy-in from the schools. The teachers themselves determined that there should be a math fair to showcase student projects. The teachers worked together to make it come to fruition. While the specific format of the fair varies from year to year and from location to location, teachers see great value in having students share their work with an audience of peers, parents, grandparents, community members and others who attend.

Secondly, the video prompt that was developed to invite students to conduct the ethnomathematical research featured community members, elders, and children inviting students to show their math. The ideas for the content of this video were developed collaboratively with teachers. We feel this video was a key component in establishing a sense of audience and in challenging traditional storylines that often have a textbook or teacher making requests of what mathematics should be done. We suggest that another community might want to create their own video prompt drawing on examples from their own community. (The original SMYM video prompt can be viewed at http://showmeyourmath.ca.)

Thirdly, schools and the entire Mi'kmaw Kinamatnewey (MK) system have embraced SMYM and have celebrated the student work. Many of the participant schools host their own local math fairs, inviting parents and community members in to view the students' projects. Walls of many schools are covered with SMYM projects. Schools commit time and funds to ensure that students can participate in the regional math fair. Some schools also provide small honoraria to elders and crafts people to come into schools to work with students in their classrooms to conduct whole-class projects and investigations (especially at the younger levels). Web space is provided to house a site displaying students' projects and MK cites SMYM as one of the major events of the academic year often providing additional funds to support the project. SMYM is a relatively simple project to organize, but it can have a significant impact on increasing culturally responsive pedagogical practices in schools.

ACKNOWLEDGEMENTS

This research was supported by a grant from the National Science and Engineering Research Council of Canada, entitled Atlantic Regional CRYSTAL (ARC): Enhancing the Culture of Science, Technology, and Mathematics across the Atlantic Provinces.

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