Ethnomathematics applied to classrooms in Alaska: *Math in a Cultural Context*

Jerry Lipka & Dora Andrew-Irhke

Math in a Cultural Context (MCC) is a long-term response to the persistent exclusion of Alaska Native language, culture, and pedagogy from the practices and norms of schooling in Alaska. MCC has brought together improbable groups of people—Alaskan Native (mostly Yup'ik) elders, mathematicians, math educators, educational researchers, teachers, and school districts. At the heart of this successful project (see Lipka, Webster, & Yanez, 2005, is ethnomathematics. Ethnomathematics (Adam, Alangui, and Barton, 2003) includes the integration of mathematical concepts and practices from the target culture to formal mathematics. MCC is one of the few ethnomathematics programs that show consistent improvements in the mathematical performance of Alaskan students (both indigenous and other students) grounded in empirical research; the project has conducted more than 15 studies, ranging from quasi-experimental to experimental designs across math topics and across grade levels (see Lipka, Webster, & Yanez, 2005). These studies meet Demmert and Towner's (2003) research criteria for evaluating culturally based curriculum and pedagogy and meets the U.S. Department of Education's (Institute of Education Sciences) criteria for rigorous research (http://ies.ed.gov/ncee/wwc/). MCC has contributed to the field by adding empirical evidence on the effectiveness of culturally based education (Education Week, January 8, 2008 can be retrieved at http://www.edweek.org/ew/articles/2008/01/09/17culture.h27.html).

What accounts for this success? MCC's approach includes the embedded mathematics of Yup'ik elders and experienced Yup'ik teachers' ways of performing and solving everyday problems. It is only because of this project's long-term collaboration over more than 20 years that we are increasingly able to understand the mathematical threads woven into authentic cultural knowledge and practices. Here we highlight the embedded mathematics in authentic cultural practices.

Dora Andrew-Ihrke a long-term colleague, Yup'ik educator, and budding math educator, has used her cultural knowledge learned primarily from her mother to make a variety of Yup'ik artifacts—patterns that adorn clothing, Eskimo yo-yos, and clothing to name a few. Through a careful ethnographic process of observing and analyzing Dora and elders, analyzing videotapes and pictures of the processes used, and with the insights of many others, e.g. Dr. Addington (mathematician), Dr. Rickard (math educator), and Dr. Adams (math educator), we have come to the conclusion that transformational geometry including measurement and proportionality is at the heart of many Yup'ik constructions in everyday life. Constructing patterns is such an example that directly connects Yup'ik everyday activity and its embedded math (transformational geometry, measurement, proportionality, properties, and proof). Figure1 shows Evelyn Yanez and Dora Andrew-Ihrke displaying Yup'ik parkas and border patterns. Evelyn Yanez in our professional development work typically contextualizes the math of the lesson through a form of storytelling called storyknifing.

Figure 1: Evelyn Yanez (left) and Dora Andrew-Ihrke (right) display two Yup'ik parkas with border patterns

Figure 2 shows a close-up of an intricate pattern.

Figure 2: "Pretend Window" pattern

It's in the construction of the border patterns on these parkas that the math is revealed. Dora always uses her body proportions to create her starting square. In Figure 3 below she demonstrates on paper how pattern pieces are created from rough uneven materials such as furs.

Figure 3: Constructing a square from uneven material

Dora begins the process of making a square by measuring the space between the first and the second knuckle, using your index finger as a way to measure; measure two of these for the length and two for the width to create a square. The "knuckle length" measure is a common unit in the Yup'ik measurement system. Cut out a square that is this size. See Figure 4 below.

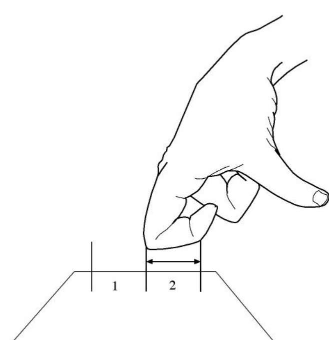

Figure 4: Body Measure

Next, she establishes a process of "proofing" that she has a square by locating the center point of the square by folding it into quarters to form smaller squares.

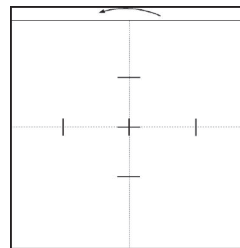

Figure 5: Center point

She used a process of folding half one way and then another way to ensure that the sides matched and she folded along one diagonal and then along the other diagonal again to ensure that each half-square matched in each direction. Interestingly, Dr. Addington, who worked with us during a December 2007 meeting, further elaborated the math involved in what Dora was demonstrating. She commented on Dora's approach to creating and checking and proofing to see if you had a square. Addington stated that if this was using a Euclidean proof it would require "something is a square when all four sides are equal and all angles are right angles." She said, "Dora checked differently. Dora is using transformational geometry. . .it is about what you do to the shape that stays the same. . .that is a reflection. . .the two sides of the mirror—the image and the original match.. . .Dora's folding along the diagonal. . .is another reflection. This goes beyond the Euclidean proof by checking in all possible ways that each reflection matches" (December 7, 2007).

In this brief example, we have provided one glimpse of the embedded mathematics that is part of Dora's Yup'ik culture as she learned these methods from her mother and other elders. This is their mathematics and it is at once accessible to Yup'ik students who have observed their parents or grandparents performing similar activities; interestingly, this approach has been equally effective with students across Alaska's diverse geographical and cultural groups. This approach to teaching and learning elementary mathematics is used in all MCC curriculum modules.

We will elaborate this approach at the NASGEm Ethnomathematics SIG at the 2009 Annual Meeting of NCSM.

References

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