The Relevance of Culturally Based Curriculum and Instruction: The Case of Nancy Sharp

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Ms. Sharp's case is particularly instructive as it shows how this experienced Yup'ik teacher steeped in the traditions of her culture effectively implemented a culturally based math module. Ms. Sharp's pedagogical creativity allowed her to authentically bring together a core academic content area, math, with Yup'ik traditions, knowledge, and ways of relating. This case shows through systematic micro-ethnography, interview data, and "insider" analysis that when Ms. Sharp used expert-apprentice modeling, joint productive activity, and cognitive apprenticeship. Her students were attentive, highly focused on the math task, and learned about symmetry, congruence, and patterns. Expert-apprentice modeling usually associated with "crafts" and usually dismissed as an ineffective classroom pedagogical tool was a key ingredient for Ms. Sharp's success. On project outcome measures her students performed well when compared to other treatment classes that used this module and to the control classes. The case shows how curriculum based on aspects of indigenous culture, combined with effective pedagogical practices derived from the community and accommodated to the culture of schooling results in appreciable student learning.

Teaching and learning mathematics is both a cultural and a personal endeavor. As Carraher and Schliemann (2002) point out, mathematics draws on "traditions, symbol systems, ideas, and techniques that have evolved over the course of centuries" (p. 132), but for the individual learner it is personal as well: "it demands from learners constructive processes and creative rediscovery" (p. 132). In this paper we examine teaching as a cultural and personal endeavor. Ms. Sharp is a Yup'ik teacher whose instruction has evolved as she has been teaching the modules of *Mathematics in a Cultural Context* (MCC). We argue that Ms. Sharp has created a style of teaching that draws upon her cultural knowledge for both the mathematical content and the process of teaching.

We find the Sharp case particularly compelling because it further defines what it means to design culturally based curriculum and to implement it

effectively and passionately. Through this case, like the others in this issue, we aim to identify classroom and contextual factors that make a difference in closing the academic gap between indigenous students and their mainstream counterparts.

Originally this case came to our attention because Ms. Sharp, a long-term teacher from the village of Manokotak, Alaska, incorporated a form of instruction nested in the traditions of her community and expertly adapted it to the mathematical content of the curriculum[1]. This paper explores how Ms. Sharp used expert-apprentice modeling that includes joint productive activity and cognitive apprenticeship. These pedagogical forms are deeply aligned with local ways of teaching and learning (Lipka & Yanez, 1998; Lipka, 1991), but Lipka had not observed them in the many years that he has observed Ms. Sharp teaching. Also compelling is the fact that Ms. Sharp's students made greater gains relative to the other classes on the project's *Parka and Patterns* tests. Also, Ms. Sharp's class made greater gains than we previously had observed when she was teaching other modules in this series, before she began to use expert-apprentice modeling and joint activity.

The *Parka and Patterns* module connects the art of creating Yup'ik border patterns to basic geometrical concepts. The very creation of making patterns involves spatial abilities. Research by Berry (1976) suggests that among hunter gather groups there is evidence that spatial abilities is a cognitive strength. This module builds on that strength and its linkage to geometry.

We believe that this case refines what it means for curriculum and instruction to be culturally relevant. We see this as an example of a "third space" (Gutierrez, Baquedano-Lopez, & Tejeda, 1999) in which the teacher has created hybrid practices that bring together community and school in support of mathematics learning. The teacher is engaged in the creative act of transforming schooling from its colonial past into a form that respects both Western and, in this case, Yup'ik traditions. Expert-apprentice modeling and joint productive activity are one of the oldest forms of instruction: They have rarely been part of Western schooling in indigenous contexts, although they are part of the local culture. The Yup'ik tradition can be characterized as one of intent participation (Rogoff, Paradise, Arauz, Correa-Chavez, & Angelillo, 2003) in which children learn through informal participation in community practices. According to Rogoff et al., "keen observation" is one key component of the expert-apprentice modeling by which children learn as older community members model a process. They also note that social roles and communication differ markedly between intent participation and typical forms of school learning in Western societies.

As we will show in this paper, Ms. Sharp's use of expert-apprentice modeling and joint activity during math lessons alters social and power relations on multiple levels. Typically, math in schools, with its emphasis on algorithms, efficiency, and absolutism and its associated pedagogical emphasis on "right" answers, invokes a teacher-student participant structure in which the teacher nominates students, elicits student responses, and evaluates those responses (Alrø & Skovsmose, 2002; Cazden, 1981). In this case we note and analyze instances

in which Ms. Sharp used the traditional school discourse pattern. We find that when she used expert-apprentice modeling and joint activity, the students' mathematical engagement changed dramatically. At those times, we will argue the one right answer and way of producing that answer are replaced by a more "level" classroom environment, in which students are free to explore within the confines of the task and are encouraged to be responsible, help one another, and find alternative ways of producing pattern pieces. Further, Ms. Sharp incorporates cognitive apprenticeship (Collins, Brown, & Newman, 1989) into her use of expert-apprentice modeling and joint productivity activity as a way to both motivate students and create a more level classroom environment. Thus, this case addresses the criticism of learning by observing (expert-apprentice modeling) as relegated to repetitive and craft-making tasks. This case study will point out that expert-apprentice modeling in school contexts can, in fact, be a powerful tool for learning conceptual material. As expressed by Lee (1995): "in a cognitive apprenticeship, the goal is to make visible and explicit thinking strategies that experts use in particular domains" (p. 613). Like Lee, we see cognitive apprenticeship as a culturally responsive way to bridge explicit teaching of concepts and the independent application of complex skills by learners.

However, we do not believe that a "third space" approach connecting and adapting local cultural knowledge with Western schooling is a linear or simple process. To the contrary, there are formidable cultural, contextual, and political differences between in and out of school learning (see Carraher & Schliemann, 2002; de Abreu, 2002). Ms. Sharp's creative weaving of a pedagogical third space while enacting the *Parkas and Patterns* module shows ways in which these formidable contextual differences can be ameliorated. The interaction of the module, Sharp, her students, and the Yup'ik practice of making pattern pieces for women's parkas [jacket-like clothing] and putting the pieces together [*tumaqcaq*] to create a whole is similarly reflected in Sharp's classroom practices. The lessons analyzed in this case show practical ways of bringing local knowledge that was once excluded from schooling into the classroom. Yet, we believe these lessons transcend her circumstances and speak to practice outside of Alaska to other indigenous and mainstream contexts. They have relevance for mainstream teachers and schools as a pedagogical form and ways of making learning both rigorous and authentic to multiple traditions.

In this paper, we describe how expert-apprentice modeling (including joint productive activity and cognitive apprenticeship) takes place, based upon a detailed analysis of videotaped lessons. We specifically highlight differences between her practice when she uses expert-apprentice modeling and when she uses more Western-oriented forms of teaching and how she effectively brings these forms together. Also, we frame the analysis through the eyes of experienced Yup'ik teachers, consultants to this project, who identify what they see as the culturally important components of Ms. Sharp's teaching.

Background to the Case

Manokotak, a community of approximately 420 people, is almost entirely comprised of Yup'ik Eskimo. It is 370 air miles southwest of Anchorage in a roadless part of the state.

Schooling began in Manokotak in the early 1950s. There is one K-12 school building in the community with approximately 142 students and a teacher student ratio of 8.4. Ms. Sharp was first a bilingual aide in the Manokotak School in the late 1970s and became a classroom teacher in the early 1980s. At that time, students in Manokotak came to school speaking Yup'ik as their first language. By the early 1990s Manokotak was the only community out of the approximately twenty-six villages in Bristol Bay in which students still spoke their natal language. Although the community gained a hard won Yup'ik immersion program in the early 1990s, the cultural strengths of the community were not included in the process and content of schooling (for a full account see Lipka, 1994; Lipka, Mohatt, & the Ciulistet, 1998). In fact, Ms. Sharp stated

> But there is still a fear or a portion of my heart that tells me not to tell totally the honest feeling or truth of what is happening to us as Native teachers. I still fear putting forth our true style of teaching, because we fear that we will lose our positions. Also, we hold back some of our voice because of this fear (Mohatt & Sharp, 1998, p. 53)

Some seven years later at the time of this case, Ms. Sharp has found her voice although most of the students coming to school are no longer speakers of Yup'ik. In fact, Ms. Sharp is now "the" Yup'ik immersion teacher. She is the only immersion teacher for grades K-3 and works with the students for part of the day. She works with a K-1 and 1-3 class in this partial immersion program.

In the late 1980s Ms. Sharp's mother, the late Lillie Gamechuk Pauk, began working with us and other elders as we began a slow and deliberate process of developing curriculum and instruction based on Yup'ik elders' knowledge. Lillie Gamechuk Pauk continued to share her knowledge and her stories with us. Lillie's penchant for making cultural artifacts, in particular border patterns that appear on women's clothing, is instrumental to the development of this case. These cultural artifacts became a critical feature of the lessons that Ms. Sharp taught.

Parka and Patterns Module

This module, like others in this series, developed slowly over many years and multiple iterations. The late Mary George of Akiachak, a long-term bilingual aide, and Marie Napoka of Tuluksak, collected the different frieze-like patterns that adorn Yup'ik women's fur parkas. Subsequently, we observed how many different elders cut their starting piece from uneven material such as skin or fur and created related geometrical shapes. Elders differ in what piece they start with, but typically shapes include rectangles, squares, and rhombi. From each starting point, symmetry plays an important role in how other shapes are derived from the original shape. Shapes are typically derived through diagonal or mid-point

cuts along lines of symmetry, which ensures that the set of patterns pieces are proportionately related. This cultural process of using symmetry, congruence, and balance (black and white need to be in balance; one follows the other[2]) formed some of the key convergence between the culture of the community and the culture (math content) of the school. Thus, the module was able to achieve a symmetry and balance between the school and community. *Tumaqcaq* [Yup'ik word], which literally means putting the pieces together, provides an analogy for how this module was put together. All the modules in the MCC series attempt to develop a third space in which the culture of school yields and mixes with the culture of the community, thus relinquishing the Western dominance of curriculum and its stifling of the creative interaction that can occur.

Methodology

Ms. Sharp and Lipka began working together twenty-five years ago and continue to collaborate. Because of this long-term relationship in which trust has been built and the possibility that this work results in improving students' achievement and supports indigenous teachers, Ms. Sharp is willing to be videotaped and to be co-analyzed. Collaborative work with elders, mathematicians, educators, and teachers provides the critical background to this case. Elders have shown and, when necessary, explained how they make their pattern pieces. Their precision is not lost on project mathematicians. In meetings over a number of years, the way different elders created pattern pieces was documented. Initial lessons were developed and tried with elders and Yup'ik teachers. Eventually draft modules were produced and piloted in schools. Observational data and videotapes of lessons were then analyzed to determine the efficacy of the curriculum and how the curriculum was enacted. From these analyses, further module revisions occurred and these refinements required further rounds of implementation and critique.

On the quantitative side, the module was tested in a 2 x 2 block design. The quasi-experimental design has two conditions: (1) treatment, where teachers are assigned or volunteer to teach the MCC curriculum or (2) control, where teachers use the curriculum in place. We also constructed our analysis along rural and urban dimensions to determine if we were closing the academic gap between mostly Caucasian urban students and mostly Yup'ik rural students. We were most interested in rural treatment vs. rural control. We ran ANOVA's and sometimes ANCOVA's when we covaried pre-test scores. Each analysis was conducted and statistical significance and effect size were calculated. [See introduction for overall project results].

Quantitative Data

As mentioned earlier, Ms. Sharp's students' performance came to our attention when we observed her use of expert-apprentice modeling and joint productive activity.

Table 1
Comparison of Ms. Sharp's Class to Treatment and Cotrol by Urban and Rural

	# of students	Average Pre-Test %	Average Post-Test %	Average Gain Score %
Rural Treatment	59	46.10	48.10	2.00
Rural Control	45	48.60	45.30	-3.30
Urban Treatment	63	53.50	56.80	3.30
Urban Control	35	56.90	51.60	-5.30
Ms. Sharp	4	31.30	38.50	7.20

As shown in Table 1 above, we compared Ms. Sharp's students' gain scores to all treatment and control groups who used the Parka and Patterns module during the spring of 2004. By block (treatment/control and urban/rural), no group gained more than 3 percent while Ms. Sharp's class gained 7 percent. This is also a strong gain score relative to other gain scores from her class on previous modules. (Note that we tested and analyzed only the 4 second grade students in her class in order to control for grade level although Ms. Sharp taught a multi-age group of students. Multi-age classes in small rural villages are typical in Alaska.) This project is most interested in classes who cross categories from low to high, particularly for lower performing schools as indicated on national and/or statewide standards tests. Manokotak is a low scoring school as indicated by the State of Alaska's Benchmark Exam (2005) for third graders (http://www.eed.state.ak.us/tls/assessment/results.html). We use third grade Benchmarks because the state does not test at the second grade level. State data indicate that less than 20% of Manokotak students were proficient at third grade math while state wide proficiency was approximately 70%. Although her class was still below the other groups on the posttest, the data indicate a reduction in that gap.

Qualitative Data

However, qualitative analysis was the key research tool used in this case. Transana, an advanced videotape analysis tool, was used. Ms. Sharp's classroom was videotaped a few times during the course of teaching this module. Sections of the videotaped classroom lessons were selected, translated, transcribed, and placed on Transana. Four hours of videotape from four different lessons and two different classes became the focal point for this analysis. Analysis of the tapes occurred in different contexts. Individual viewings occurred until the scenes were familiar almost to the point of memorization. Scenes were identified and discourse and video were linked through Transana. These classroom events were catalogued and categorized. Key elements from each event were analyzed. Video analysis meetings with colleagues occurred periodically. Most influential were meetings in which Yup'ik elders and expert Yup'ik teachers joined with outsiders, typically university faculty. These meetings were fruitful for bringing out emic understandings of transactions between the teacher and her students. This allowed us to pinpoint exact moments within the classroom videotape when the Yup'ik

consultants to the project—Evelyn Yanez, Dora Andrew-Ihrke, Mary Beans, and Sassa Peterson—said that classroom incidents would make them comfortable, invite them to learn, and feel that they were wanted and could succeed. Ms. Sharp also met with the authors and elders on a few occasions as she observed and commented on her teaching, as well as asking the elders to observe and comment on these lessons. We also interviewed Ms. Sharp on a number of different occasions. Parenthetically, it is important to note that we bring to the video analysis hours of first-hand classroom observations of Ms. Sharp as well as other Yup'ik and non-Yup'ik teachers in rural and urban Alaska. These mental images and ways of teaching are compared against what we viewed while watching the current videotapes. Also, we note that not all aspects of the lessons are taught in the same way for the same purpose or engage students equally well. All of these comparisons form part of the analysis.

The Case

The case unfolds during the spring semester of 2004. This is the first time that Ms. Sharp began teaching this particular module. The importance of this module was highlighted by the cultural artifacts that adorn her room related to teaching the *Parka and Patterns* module. Most notable were her mother's unfinished parka pattern strips, which hung in the front of the room. She also carried a bag full of parka pattern pieces that her mother was also putting together. This module tapped into local content (how to make geometrical shapes) and pedagogy (expert-apprentice modeling). The excerpts from classroom transcriptions and video analysis begin to tell the story of how Ms. Sharp put these lessons together. The case presents transcriptions across two different mixed age classes, K-1 and 1-3. (Mixed age classes are common in rural Alaska.) The analysis follows key aspects of the lesson.

Videotape Analysis 1

Connecting the Culture and the Math

We join Ms. Sharp's kindergarten and first-grade class during the second lesson of the module. There are two rows of six students per row and another group of students seated around a semicircular table facing the front of the room. She has two parkas (women's winter coats) hanging on the white board and different shapes with their names written in Yup'ik. Next to it are Yup'ik pattern strips and a series of posters showing parkas with different border patterns. The posters are framed by a Yup'ik border pattern. Typical designs include a black square or rectangle followed by a white one in a repeating pattern.

Ms. Sharp's teaching of the lesson transitions through three different participant structures, with varying degrees of cultural congruence. It begins with her asking questions and the students responding with short answers, often in chorus. This is the participant structure commonly seen in the traditional mathematics classroom. As the students seem to lose interest in the lesson, Ms. Sharp then moves to modeling the mathematical activity that she wants the

students to do. The lesson concludes with joint activity as Ms. Sharp joins the students in creating different geometric shapes from the paper. Each transition seems to lead to greater involvement and participation on the part of the students.

The Patterns and Parka lesson begins approximately five minutes into the videotape. Ms. Sharp points at the parka that is displayed in the front of the room. Patterns are sewn onto it, and she asks the students what they are.

Sharp: What are these?
S: Yes.
Sharp: What do you think they are?
S: Fur. What?
S: Fur.
Sharp: Yes, they are furbearers, but what are these? What kind of shapes?
S: White one.
Sharp: Diamond.
S: Diamond.
Sharp: What else are they? What do they seem to be?
S: White.
S: A square.
Sharp: Squares. What about these?

Students respond in English and Yup'ik by naming the different shapes such as diamonds, squares, rectangles, and triangles. Students continue to repeat the words in a choral fashion, with many mistakes as the students try to figure out what information the teacher is seeking. She repeats this process as she points out the different pattern strips that are hanging near the parkas.

In the next excerpt, Ms. Sharp begins to connect the math and the cultural component of the lesson.

Sharp: A rectangle. Looks like this is a rectangle. It's long like this. It is long. Do you understand it?
S: Yup.
Sharp: The way I see it, but one that looks like this, what is it?
S: A square.
Sharp: A square. Do you know what a square looks like here?
S: Yeah.
Sharp: Go point to it. Yeah, a square. These here are patterns, patterns. And these are what kind?
S: Squares.
Sharp: Square patterns. What about these?
S: A triangle.
Sharp: Triangle. What are they pretending to be?
S: A rectangle.
Sharp: What are they pretending to be?
S: Rectangle.
S: Grass.
Sharp: From our house, in Manuqqutaq [Yup'ik pronunciation of Manokotak], when we look around across there, what do we see?
S: Mountain.
Sharp: What are they? "I ..."

[Ms. Sharp is trying to come up with the word *ingriq* which is the Yup'ik word for mountains...]

Sharp: What are mountains in Yup'ik? *Ing ..., ing ..., ingri ...*

S: *Ingriq!*

Sharp: *Ingriq*. Like this: *ingriq*. These here are what they call "pretend mountains." Now say it. Together "pretend mountains, pretend mountains." Now I'm going to let you make ah, can you make a square one?

She demonstrates and shows with her hands the triangular shapes on the pattern strip that symbolize the mountains surrounding the village of Manokotak. Yup'ik border patterns often symbolize local geographical features such as rivers or mountains. Students are learning shapes, distinguishing shapes from one another, and learning their cultural and symbolic meaning. The student responses are focused on the mathematics as well as the cultural meaning of geometric shapes. She puts out an invitation to the students, "can you make a square one?" This sentence also serves as a boundary marker, and we will revisit it further into the transcription.

At 9 minutes 28 seconds into the lesson, Ms. Sharp reorganizes the room by moving the chairs and tables out of the way so that the students may work on the floor. In the next phase of the lesson the students are supposed to make squares from uneven material as if they were working with skins to make patterns. We rejoin the class at 10 minutes 40 seconds:

S: Put the chairs over there?

Sharp: No, without chairs, on the floor and without pencils. Put your pencils away. [Off camera she is ripping the construction paper for the next activity]. Now listen, I'm going to give you one that's this big. Now you, how are you going to make a square?

S: Cut?

Sharp: Using scissors first? How are you going to do it?

S: Tear.

S: A white one.

Sharp: Ah?

S: Tear.

Sharp: How are you going to do it?

S: A square.

Sharp: How...

S: (inaudible) [...no room.]

Sharp: How are you going to make it into a square?

Sharp: How are you going to make one? How can you do it? [calls on student by name].

S: (inaudible)

Sharp: No, I'm not going to do it for you. You, you, you, how can you make one?

S: Tear?

Sharp: How can you make one?

As she asks the students how they will make a square, she tears off pieces of black construction paper and hands them to the students. Sometimes she uses her hands to draw a square in the air, but students are not quite following.

Although they respond with answers such as tearing or scissors, they are not sure and they lose interest. They begin to turn their black construction paper into hats, and a number of students put these cylindrical "hats" on their heads. However, Ms. Sharp does not lower her expectations and says to a student, "I'm not going to do it for you….How can you make one?" This is a key characteristic of her teaching, placing and keeping the responsibility and the complexity of math tasks on the student. This phase lasted approximately seven minutes.

The next phase differs from the previous phase as Ms. Sharp begins modeling the process and coordinating her modeling with her verbal instructions, a different instructional method and a different participant structure. She signals the transition with the question, "Should I show them one?" This question was highly significant to the Yup'ik viewers of the tape. This is a critical incident in this lesson.

As she says, "should I show them," she tears a piece of construction paper for herself and students watch what she is doing. Within a few seconds all of the "hats" have once again become black construction paper that students are about to use to make squares. She shows them a square and asks them to look. The students move closer to her almost in unison. They are now in a tight circle observing her. A few seconds later we rejoin the class.

Sharp: Fold it. *Kerry*, fold it. Now, what can you do if it's going to look like this? Yes! Make sure this part is exactly the same, okay? You're not going to do it in any old way like this but, you know, straight, straight. Look. Straight, see. It's straight. So, if it's going to be a square like this, how are we supposed to do it?

S: *Nanuk*. [Ms. Sharp's Yup'ik name]

Sharp: Yeah, do it carefully. Okay. Then how are you going to cut it? What are you going to do?

S: *Nanuk*!

Sharp: Ah? Make it straight. You have to make this part straight. Make it straight. Look, is this straight? Is it straight? Is it [straight]?

By 18 minutes 30 seconds, all of the students are engaged in making squares from the construction paper. Ms. Sharp's questions seem to focus the students on important components of the geometric figures, rather than requesting small bits of information. Mathematically she has introduced the concept of paper folding and stressed that the folded parts need to be straight, symmetrical, and congruent. These will become important mathematical tools for the students in subsequent lessons. She emphasizes that it needs to be straight and not done "any old way." She compares some students' work and points out the difference between rectangles and squares. She continues to reinforce the theme of keeping the responsibility of doing work on the students. Students are basically working individually as she continues to help them and continues to model.

Sharp: Yourself, yourself, think about it. The squares you make... Look, those squares up there were made. How can you make yours? How can you make a pattern? [Yeah], go ahead and make some and then [glue] them. Move over this way, here.

S: *Nanuk*

Students continue to make many squares and begin to make patterns as she again encourages the students to think about how they will make their square. At 31 minutes Ms. Sharp begins the final phase of the lesson—joint activity. No longer modeling, she now sits in the circle with the students and begins making her own pattern pieces. She and the students are now working in parallel as they make pieces and glue them into patterns. Students occasionally observe what Ms. Sharp is doing or show her their work.

Figure 1. Joint productive activity.

At approximately 45 minutes students have finished their work. However, Ms. Sharp continues to make her pattern while a few other students are finishing their work. Other students have gone out for recess. At 48 minutes into this lesson she is the only one left as she finishes her pattern.

She states:

Sharp: I'm done.
Sandi: And tell us about your pattern. [The videographer, Sandi, asks Ms. Sharp to explain her pattern.]
Sharp: Squares and these are pretend mountains and this is *Iiyuussiiq* and this is *Tegingaq*. [Igushik and Weary rivers which are near the village of Manokotak.]

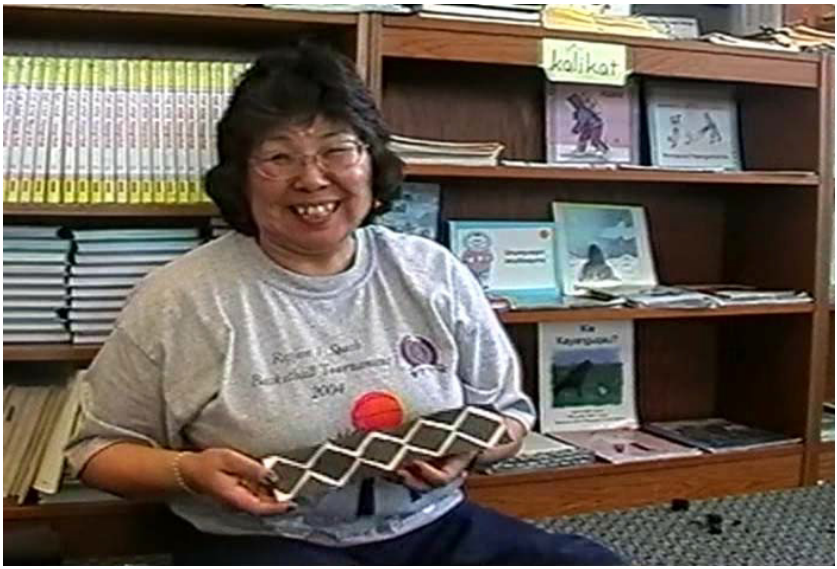

Figure 2. Ms. Sharp displays her work.

In this lesson, Ms. Sharp moved from a traditional participant structure to structures that increasingly reflected the ways that Yup'ik teaching and learning occurs outside of school. To some degree, her shifts seem to have been stimulated by a need to more deeply involve the children in the lesson as they became restless and distracted. However, when she began modeling, coordinating her instructions with her physical activity of modeling, the students attended and re-engaged in the activity.

In the next two analyses, we see the same sequence unfold over the course of three lessons with an older group of children.

Videotape Analysis: Building the Mathematical Tools

The next analysis looks at lesson 2 of the module with older students, a class of first through third graders. Although this is the same lesson as in the previous videotape analysis and Ms. Sharp begins by reviewing geometric shapes, her expectations for the class seem to be somewhat different. The student desks are in rows and she uses a chart with examples of different geometric shapes rather than the shapes on a parka as with the younger class. She quickly moves from simple identification of shapes to their properties. However, her initial participant structure is similar as she asks questions and students respond verbally. The lesson evolves into more complex forms of modeling and an emphasis upon Yup'ik values as students work on creating geometric shapes by using mathematical properties.

The lesson begins with Ms. Sharp asking students to identify geometric shapes, with more emphasis upon Yup'ik language as the students strive to answer the questions in Yup'ik, with less English than in the younger class.

S: Rectangle?
N: In Yup'ik...What?
S: A *yaassiigenqellria*? [S: Asking "A square?"]
N: Here is a square. [She points to a square] What does a rectangle look like?
S: *Pingayulek*? [Triangle]
N: Here is a triangle. [She pointed to the triangle] What is a *yaassiiguaq* [square] look like?
S: *Tumaqcaq*? [pattern?]
N: Yeah, it can be a *tumaqcaq*. What is a *yaassiigenqellria*? Mary? How is it like this (making a square in the air)? Oops, I'm saying the wrong one, a rectangle. [She points to the rectangle on the board and then contrasts it to the square]. A square has equal sides, but a rectangle is like this, like *Jenny* said.

In contrast to the younger children, these children seem to understand what kinds of responses are expected by the teacher and they respond individually rather than in chorus. But they still make mistakes. It is difficult to say if the students are having trouble because they do not know their shapes or because they are second language Yup'ik speakers. They may be having trouble remembering the Yup'ik terms for the different shapes.

The next part of the lesson is about the properties of shapes, and the questioning continues with the help of many gestures on the part of the teacher and drawing on the board. The student responses continue to be brief, with elaborations by Ms. Sharp. She then invites them to the board to draw lines of symmetry.

S: It's long.
Sharp: It's long. What else? They're the same. [*ayuqut*] they're the same, meaning the lengths.
S: It has symmetry.
Sharp: It can be symmetrical. What else?
S: It can be symmetrical.
Sharp: It can be symmetrical, yes. See, this is a rectangle. What is it like? What is it like?
S: They're the same.
Sharp: What are the same?
S: Two.
Sharp: Two lines are the same. What about the other sides?
S: Four?
Sharp: These two are long. That's why it's called a rectangle. We can also put it this way.
S: [7:04] Symmetry.
Sharp: Yes, it can be symmetrical. How? If I cut it this way, will it become symmetrical?
Sharp: Then how? You do it. Who can do it? Which way can she do it? [A girl comes up to the board to draw the line. The girl draws one

line of symmetry bisecting one pair of equal sides and then another line of symmetry bisecting the opposite sides.]

Ms. Sharp continues to challenge students to find lines of symmetry. Several students volunteer to draw on the board by raising their hands. Student after student comes to the board and draws lines of symmetry in the square. At first, students draw the diagonals and eventually they find all four lines of symmetry—the diagonals and mid points. At least implicitly they see the difference between the properties of rectangles and squares, because the rectangle in the drawing below shows two lines of symmetry. Ms. Sharp challenges students to find additional lines of symmetry and additional shapes such as triangles and parallelograms. This seems to represent an important transition in the lesson, as the teacher expects nonverbal responses and more students are actively participating in the lesson.

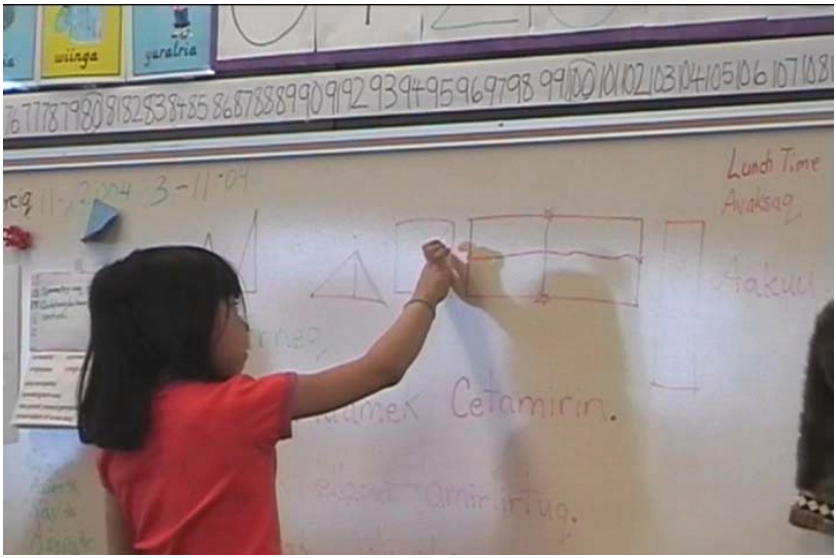

Figure 3. Student finding lines of symmetry.

After this Ms. Sharp continues a verbal explanation of parallel lines and compares the sides of a parallelogram to that of a triangle. At 18 minutes into the lesson, she makes one brief connection to Yup'ik culture by pointing to the border pattern of one of the parkas on the board and showing how it is made of squares. She then talks about cutting pieces into parts that will be used to make a pattern, a prelude to an activity later in the lesson. At this point the students begin to write in their math journals, and for the next 16 minutes she helps them with writing Yup'ik words and sentences about the mathematical content that has been covered.

After Ms. Sharp reads a story unrelated to the math lesson, she continues teaching the module. Unlike the earlier part of the lesson, the students are now standing and sitting around a central table, and a major transition occurs in both the instructional method and the task for the children. The goal of this lesson is to make a variety of small pieces to be used in making a pattern, using the mathematical properties talked about earlier. Each student begins with a 3-inch square of paper. However, each student will end up with their unique set of pattern pieces following the "rules" of using symmetry, congruence, and midpoints as a way to cut out related pieces from the larger square. We rejoin the lesson as Ms. Sharp describes the next task to the children.

Sharp: We did that. So, this morning ... some of you did slightly different ones and some of you cut these out. Now, this morning, can you make different ones? I'm going to give you this. Can you make a different shape? Who can make one? Use this to make a different shape, but you have to think about it. You know, not waste, don't waste, because we will use these, we'll put them in here. What are you going to make? What are you going to make? First, tell us. How are you going to make it? Now do it right there.

Her instructions stress cultural models for carrying out the task, rather than the mathematical ideas stressed earlier. The students are told they are going to make a variety of pieces, but not which shapes to use. The repeatedly stressed theme of not wasting begins in this opening to this segment of the lesson. From a cultural point of view this creation of pattern pieces is more like a work task than a free exploration of how different shapes are created. In the next minutes, Ms. Sharp has various students model how they will cut out their pieces as the other students watch intently. Ms. Sharp hands a boy a square of paper.

Sharp: What are you going to make? First tell us. Here, use this, I think it is better. What is it? What are you making? *Steve*, come over here. What are they? What are you making? [50:15] Student folds square in half in one direction and in half in the other direction. She takes it away from him and gives him another piece to fold as the other students continue to watch.]

S: A square.

Sharp: A square? Look at that very closely. What are you making?

S: Cut it. [52:20].The first boy cuts out the little squares as the teacher calls on a second boy in blue to fold a square. He folds it along the diagonal, standing where the teacher had been sitting a moment ago. The teacher hands out more squares to the other students while these two boys are working in front of the group. By 53:40 all of the students have begun folding their paper squares.

As the two boys modeled two different ways to fold a square and cut it into proportionally related but different shapes, the students and teachers were mostly silent. After the boy in blue folded the square into two triangles, the rest of the class began working on their squares. At this stage, Ms. Sharp had guided the students into the role of more experienced apprentice modeling for other students.

The students continued to work silently around the table, occasionally looking at what other students were doing. Ms. Sharp continued talking as she walked around the room to see what the students were doing. The following excerpts give a flavor of the last 10 minutes of this lesson.

> N: [56:00] Does someone else want to make one? Go over there. Here, you have to make different ones, but don't waste them. You're going to put them on these. You're going to put your creations on these, but you have to say what you are going to make. What else can you make? Will they be the same when you put them down? Yeah? Can you make a different one? Can you make a different one?
>
> N: [60:00] You have to make them the same size. If you make this shape you have to make them the same size, or if you do this shape, make them the same size, or if you going to do one of these shapes, they have to be the same size. Some big, some small, not like that but all the same size. Do you understand? What are those? What is it? How do we say that? Say it loudly. A rectangle. Can you make another one? Make them symmetrical instead of cutting them quickly and you can't waste them. You have to put them into your envelopes if you want to. But fold them and make them symmetrical. Make them symmetrical by folding them.

Throughout these last 10 minutes, Ms. Sharp stressed four things: (1) Each student would be making different things—different sizes, different shapes. (2) Throughout this process the students had autonomy in what they made and how. (3) There should be no waste in the process. At the end of the lesson, each student saved every piece of paper in their envelopes for the next lesson. (4) The principle of symmetry, i.e., using the mathematical properties of the shapes, was to guide the process.

As in the lesson with the younger children, this lesson flowed from a traditional mathematics lesson with strong teacher control to a structure that integrated Yup'ik and school culture. At the beginning the student actions were restricted to verbal answers to closed questions asked by the teacher. Midway through the lesson, the teacher called students to draw lines of symmetry on the board, allowing nonverbal participation and a diversity of responses. Student involvement increased as multiple students volunteered to participate, although they were well behaved throughout. In the last part of the lesson, all students were actively engaged in creating pieces. Interestingly, as the camera panned around the room, it could be seen that indeed each student was creating a unique set of pattern pieces.

Putting it All Together

We rejoin the first through third grade class on the following day as the students are going to make bookmarks based on the Yup'ik pattern set. Their work builds on what they have been learning about, both mathematically and culturally. This lesson pulls these different components together through this project. The students

are seated around Ms. Sharp in a circle so that they can all observe. She has bags of leather pieces in front of her, some of them individual shapes while others are complex patterns on strips that would form the border of a parka.

Sharp: Remember we were working on patterns yesterday? These here are patterns. Patterns. Now, say it [in Yup'ik]. [She holds up a black and white square pattern that her mother made].
Students: Patterns.
Sharp: These are patterns. Patterns. Yes, mother made these. Do you see these? What are they?
Students: Patterns.
Sharp: No, what are these?

In this brief excerpt she connects the bookmark project and making patterns to her mother's pattern strips. Her mother, Lillie Gamechuk Pauk, was recently deceased. She was related to some of the students in the class. This personal and cultural connection to the students' schoolwork links directly to students' experiences in the community from knowing Lillie and seeing other elders make patterns. For the next 14 minutes, Ms. Sharp discusses the various pieces, interweaving the names of Yup'ik patterns, connections to the landscape, and many mathematical ideas such as symmetry, conservation of area, congruency, and parallel lines. As she talks, Ms. Sharp models both cultural and mathematical ideas with the pieces her mother had made.

The following videotape section shows a very subtle transition from expert-apprentice modeling to joint activity, thus preparing students to engage in the task of making their bookmarks. As part of the transition into joint activity, Ms. Sharp extends her modeling to include a form of cognitive apprenticeship. She now has the paper squares and strips that will be used to make bookmarks in front of her. She starts folding and cutting some pieces. The classroom excerpt follows:

Sharp: How can you make a square? You can use these little pieces. Remember I gave you envelopes yesterday? And also gave you this kind? Do you understand? First make folds. Fold it in a [symmetrical way], first.
S: (inaudible)
Sharp: [Yeah] I plan to make different kinds. [The students are observing her as she folds her paper. She begins to hand out the strips for the students to make their bookmarks.]
S: A triangle.
Sharp: After making folds, we'll be able to do it.
S: A rectangle?
Sharp: [Yeah] a rectangle. I wonder what I should make. What kind would you like to make? [This occurs at approximately 25:40 in the videotape].

Her modeling now includes a form of cognitive apprenticeship: She talks aloud about what she is thinking. As she folds her paper to make the pieces she has in mind, she runs into some difficulty. Students have the opportunity to observe an expert at work and how an expert resolves problems. It is the last sentence in the excerpt that the Yup'ik teachers pointed out as being extremely

important to them. Evelyn Yanez said that when "Nancy [Ms. Sharp] said 'I'm going to try to see if I can make one. I don't know what the end product will be but I'm going to try. I'm going to see if I can make something. I'm not sure if I can.' If I were her student, I would want to see what my end product will be, she doesn't know what her end product will be, will want to see if it's different." In addition, Dora said "It's structure, it's planned but you don't know what the outcome is going to be."

We rejoin the class at 26 minutes. Sharp says: "You can put your stuff into your envelopes. They're with your things." This is the cue for the transition. The only other cue was from a student saying he needs scissors. Students begin to disperse and move to other tables. They organize themselves and there are no other instructions from Ms. Sharp regarding who works with whom or where students sit. There are only occasional reminders about not wasting and remembering to create symmetrical folds. For the next 36 minutes the students are working independently while Ms. Sharp stays at the same table where she was demonstrating. Some students join her. This is another instance of joint activity. Students observe her occasionally. She does not walk around the room and monitor students' work. Students occasionally help one another or refer to the parka patterns on the bulletin board. Ms. Sharp highly values the end product and the teaching method that she uses conveys that.

Evelyn Yanez again refers to the scene above. "She is telling me, coming down to my level. Oh, she is going to make one. But she doesn't know what it is going to look like. Maybe, I can make something with the *tumaqcaq*. Motivating me to—she is no longer a teacher, she is going to make one just like us. I think that would make me want to make a bookmark right there"[3] (E. Yanez, personal communication, December 6, 2004).

Through the end of this lesson, the students and Ms. Sharp create bookmarks using pattern pieces that they had just cut out, using the same procedures used in the previous day's lesson. In this lesson, they had to scale down their pattern pieces to fit the bookmark strip, which was smaller than the squares she handed out to the students. Each student made a different design as shown when each student holds up his or her bookmark for the video camera. Other teachers observing the students' work remarked on how much diversity and creativity was in their patterns.

There are several important features of modeling and joint activity as used by Ms. Sharp in her lessons. The directions she gives are heuristic rather than procedural. Aspects of process are specified (folding, using mathematical principles) but the end product is open to the student's choice of pieces and patterns. Thus teaching by modeling does not have to result in learning by copying; in fact it should not be a process of copying. Her cognitive modeling—"I wonder what I shall make?" Gave students pause to see that their teacher needs to think through this process and decide upon a pattern. Her pattern, as well as each student's pattern, should be different from the others. Joint activity also puts the creation of the bookmark into the realm of work rather than exploratory

learning. As with all work in the Yup'ik community, it must be governed by conserving, not wasting as well as a well-made end product. The extremely smooth transition into the joint activity suggests that this is a familiar and comfortable way of working for these Yup'ik children; such smoothness is seldom seen in other school lessons.

Conclusions: What Can We Learn?

In our detailed, ethnographically oriented videotape analysis of four of the lessons that Ms. Sharp taught using MCC's *Parkas and Patterns* module, we found specific classroom interactional patterns that changed the classroom participation and authority structures toward more active student engagement. In this final section of the paper, we summarize the key features of these participant and authority structures and their importance. In addition, we describe an emic perspective as provided by the Yup'ik consultants on the project. We then discuss how the overall structure of the lessons seems to be an example of culturally relevant cognitive apprenticeship. The paper concludes with the broader implications of the lessons learned from this case to teaching and learning in other American Indian/Alaska Native contexts and beyond.

We noticed in the early phase of the first lesson, while Ms. Sharp was working with the kindergarteners and first graders, the students had difficulty following her verbal instructions. A key transition in the lesson occurred when Ms. Sharp turned to the videographer and said "Should I show them one?" The students refocused, moved closer to her, all off-task behavior ended, and within a few minutes all of the students were actively engaged. Evelyn Yanez offered the following interpretation, "you have to show it instead of just talking about *qalarutkeqainarpeknaku, piluku,* verbally and kinesthetically, that is how I was raised…. My dad always says that a person could be very verbally telling people how do things but if he can't show then he may not know"[4] (E. Yanez, personal communication, March 15, 2005). When Ms. Sharp coordinated her verbal behavior and her physical modeling, students were eager to get involved. In doing so, the students demonstrated their skill and comfort in using "keen observation," a hallmark of intent participation as described by Rogoff et al. (2003).

The next 20-plus minutes of that lesson consisted of joint activity with Ms. Sharp seated on the floor right alongside the students, modeling as she produced her own work. Joint activity was again used in the final lesson as the older students produced diverse and creative bookmarks. Joint productive activity in each instance appears to have changed the classroom dynamics in terms of students' rights, responsibilities, and ownership (the participant structures). Students were responsible for whom they worked with, where they sat, whom they spoke to, and whom they asked for help. Ms. Sharp went to great lengths to ensure that the students realized that this was their work by using statements such as, "what will you make?" Similarly, by keeping the boundaries clear between herself and the students, she ensured that the students were responsible for their work and she maintained high academic expectations. Ms. Sharp did not

micro-manage the students. She did not go around observing each student's work. Instead, she did most of her didactic instruction and guiding in the first half of the lesson when she went over symmetry, congruence, and midpoints as well as emphasizing Yup'ik values about not wasting. Expert-apprentice modeling further reinforced those mathematical concepts through the task and in multiple ways as students continued to have multiple models to observe. She further created a more level relationship between herself and the students by joining them and working on her own patterns and some of the time students were in the role of modeling for other students.

Ms. Sharp made a critical transition to joint activity in the lesson with the older children when she said, "I wonder what I should make?" The Yup'ik consultants to this project pinpointed that instant as important to them, that it would challenge them and make them interested to try. They further related this to learning in the community. Evelyn Yanez stated, "They [the elders] never forced us to do anything. If he wanted to learn something, he'd sit down and just watch."

It appears that Ms. Sharp created a classroom environment in which she connected students' everyday experiences of making patterns, a task that continues in the community, to how learning occurs in the community. The beauty of her creating a "third space" is that she brought a core academic subject, math, and connected it to everyday knowledge and ways of learning in a school setting. The math and the culture were both authentic and appropriate for the setting. The students' care and attention to their pattern making was evidenced by the diverse pattern sets that they made, and we believe this occurred because it connected to making Yup'ik border patterns. Ms. Sharp noted that the students treated their paper patterns and projects as if they were the actual items, treating them delicately. The class had a very task-oriented and work-oriented feel to it. When interviewed about what made this lesson successful, Ms. Sharp said she "felt comfortable." She continued,

> I was using examples that were in my blood. To show off what my mom had left behind. I felt that I was passing knowledge on to the younger kids. It was real. It was not artificial. These were pieces that mom had worked on. She didn't finish them[5] (N. Sharp, personal communication, May 31, 2004)

Ms. Sharp's use of modeling, joint activity, and culturally relevant pattern creation seems to fit together into a system of culturally relevant cognitive apprenticeship adapted to schooling. A major goal of cognitive apprenticeship is to make explicit the tacit knowledge that experts use when carrying out an activity. The beginning of each lesson analyzed in this paper used more traditional classroom teaching techniques to make the mathematics explicit. Although the traditional Yup'ik process of making pattern pieces through folding along lines of symmetry may have been familiar to the children, the naming and explicit mathematical properties of different mathematical shapes are necessary components for school learning. As described by Collins, Brown, and Newman

(1989) and Lee (1995), a goal of cognitive apprenticeship is to enable learners to undertake complex tasks independently, often with the support of peers. Ms. Sharp prepared her students for independence and "released" them into productive work groups once she and other students had modeled various aspects of making pattern pieces. As noted above, the beginning of independent work was signaled by culturally salient transition to joint activity.

This case has been instructive for us regarding effective implementation of culturally based curriculum. Through this module, *Parkas and Patterns,* Ms. Sharp made multiple connections between the culture of the community and the culture of the school; this did not happen while she taught other modules in this series. It may well be that she found her voice as she became a mature user of MCC curriculum, or it may be that the specific math content of this module aligned more closely to familiar community activities. Similarly, the relationship of this module to spatial ability and her comfort with making patterns may account for some of the differences in both student outcomes and classroom processes while teaching the Parka and Patterns module. Theoretically and practically, this means that the concept of culturally based and what it implies may well need to be more specifically defined to have relevance for particular teachers in particular contexts and teaching particular subjects.

The notion of culturally based curriculum in a core academic content area reveals the academic options available to indigenous people. Hooks (1994) has called this "engaged pedagogy," in which the marginalized or "marked" culture takes center stage, becoming "unmarked." In the Sharp case, we argue that not only has the local indigenous context and pedagogy become the engaged pedagogy, but the lessons learned from this case offer insight to others in AI/AN contexts as well as to mainstream groups. We believe that cognitive apprenticeship along with expert-apprentice modeling and joint activity are legitimate pedagogical approaches, appropriate across different contexts. Therefore, the Sharp case illustrates how one of the oldest forms of teaching and learning, expert-apprentice modeling, and increased academic engagement have influenced the academic learning in Ms. Sharp's class. The use of expert-apprentice modeling in a math lesson also showed how Ms. Sharp altered the conventional authority and participant structures. As she increased student ownership of the task, she simultaneously altered the way she related to the students and the task and the way the students related to her and each other. This is a major accomplishment and one that can be applied elsewhere. Further, this case shows that culturally relevant curriculum and pedagogy needs to be more finely understood in terms of the particular participants in context, rather than simply suggesting that if the content and/or pedagogy reflect the culture it will resonate with the participants.

In our work in MCC, these lessons stand out as one of the best examples of how to integrate academic learning and local knowledge in an authentic way. Ms. Sharp's students' test results provide supporting evidence that this was an effective approach.

Although these lessons were done with Yup'ik students in a Yup'ik setting, we believe that the lessons learned here go far beyond Manokotak, Alaska. For years, federal reports and university researchers have called for connecting the culture of the community to the culture of the school. Too often, however, these calls have been vague and general. This case presents concrete ways in which it can be done. In different settings, different community and everyday knowledge will be salient. Bringing these pieces together and putting them together in a pattern to fit the context of others is the challenge and opportunity that this case inspires.

Jerry Lipka has 24 years of experience in the Alaskan context and has written extensively on the subject of culturally based education. He is the senior editor of *Math in a Cultural Context,* a supplemental elementary school math series based on Yup'ik elders knowledge. He has published extensively using an ethnographically oriented approach.

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Evelyn Yanez, a former Yup'ik teacher and state recognized bilingual educator, has been involved in education for the past thirty years. She has played a direct role in organizing classroom observations in southwest Alaska schools. As a former bilingual coordinator for Southwest Region Schools, she has tested students to orally ascertain their Yup'ik competence. Yanez has also had experience in collecting, recording, transcribing, and translating traditional Alaska Native stories from Yup'ik.

Ferdinand Sharp has been a consultant for Math in a Cultural Context and other related projects for many years. His principal role has been supporting elders and their knowledge. He has actively worked to ensure that their knowledge is included in the math modules. He has also contributed by observing classes, administering tests and performance tasks, giving talks at conferences, and assisting at workshops.

Nancy (Nanugaq) Sharp has been a teacher since 1985. In her school, she is the Yupiaq Teacher and speaks the language fluently. Nanugaq has been working with elders since she began teaching. She has deep respect for the elders and is a bridge between the outside world, the elders, and her teaching. Nanugaq is a role model in her community and in her teaching as she connects the Yupiaq Math to the school's regular math. She continues to teach with high expectation for her students to survive in two worlds.

Endnotes

[1]A related case of Ms. Sharp was submitted to the *Bilingual Research Journal,* forthcoming. The present case goes beyond the scope of the original paper, using additional classroom videotape.

[2]From observation of Yup'ik patterns on women's garments and discussions with Evelyn Yanez, a retired Yup'ik teacher from Togiak and consultant to the project, we believe that the black and white pattern follows a cultural rule.

[3]Comments by N. Sharp during personal interview in Fairbanks, AK, May 31, 2004.

[4]Comments by E. Yanez during a video analysis meeting in Fairbanks, AK, March 15, 2005.

[5]Comments by N. Sharp during personal interview in Fairbanks, AK, May 31, 2004.

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