Journal of American Indian Education

Volume 33 Number 3
May 1994

CULTURALLY NEGOTIATED SCHOOLING: TOWARD A YUP'IK MATHEMATICS

Jerry Lipka

This paper describes one aspect of a long-term collaboration between the author and a Yup'ik teachers' research group, Ciulistet, focusing on the processes and development of Yup'ik culturally based mathematics. The premise behind this work is that the Yup'ik language, culture, and worldview, particularly subsistence activities, contain mathematical concepts. These concepts include a number system that is base 20 and sub-base 5, and ways of measuring and visualizing. This has direct applications to school math. However, just as important, the project participants are increasingly realizing the potential of using their culture and language as a means to change the culture of schooling.

Numerous calls for transforming American Indian and Alaska Native education have been made and gone largely unheeded. This lack of responsiveness by the educational establishment continues to underscore the colonial nature of schooling which too often undermines indigenous language and culture. Research from the 1928 Meriam Report to the 1991 Indian Nations at Risk study indicates that increased local autonomy and actively valuing elders' knowledge will strengthen indigenous schools (Meriam, Brown, Cloud, & Dale, 1928; U.S. Department of Education, 1991).

The present paper describes a deliberate process to change the context and culture of schooling in a few Yup'ik Eskimo communities in southwest Alaska. The process of changing and negotiating the culture of schooling is one of collaboration with Yup'ik elders, teachers, community members, administrators and university faculty (see Note 1). As a result, the opportunity has been created for insiders and outsiders to come together to re-examine what constitutes school content, to value Yup'ik social processes by incorporating them in teaching, and to provide fresh insights into bridging the gap between Yup'ik ways of knowing and schooling. This article describes the collaborative efforts of the Ciulistet (leaders), a Yup'ik teacher research group, and reports on our preliminary findings. The discussion here highlights the possibilities of transforming the teaching of school mathematics by incorporating within it Yup'ik knowledge, culture, language, and everyday experience. The effort is part of a larger ongoing collaboration of more than a decade.

Background

The Region

The region's villages range in size from approximately 60 to 600 people. Each village has its own primary school, and most of the larger villages have their own secondary schools staffed with one to 10 teachers. Multigraded classrooms and teachers who must teach outside of their area of expertise are a fact of life in rural Alaska schools. Teacher turnover rates remain between 5% and 20% per year. Children speak Yup'ik as a primary language in only one of the 26 Bristol Bay communities, a region of southwest Alaska. National standardized reading test scores continue to be quite low, ranging from approximately the 7th to the 50th percentile across the region's schools.

Yup'ik bilingual programs teach students a Western color system and teach students to count to 10 using a Western base-10 system instead of a Yup'ik base 20 and sub-base 5 (C. Hensel & R. ltuzu-Mitchell, personal

communication, 1993). The majority of bilingual programs are pull-out programs, providing students with limited time for Yup'ik. This points to the decontextualized and marginalized place of vernacular and indigenous languages within the school context (Hakuta, 1986). The lack of attention paid to Yup'ik knowledge systems, Yup'ik values, and Yup'ik social processes means that schooling further marginalizes and Westernizes Yup'ik culture and language.

The Case

Although Yup'ik language and culture are under enormous pressures at the end of the 20th century, Yup'ik is one of the few Alaska Native languages expected to survive into the next century. The factors contributing to the school-based marginalization of Yup'ik culture and language include English-only schooling and related publicly held views of Yup'ik as a low-status language. Fears that Yup'ik will interfere with children's learning further marginalizes the place of Yup'ik in schools.

Despite these pressures, a rich cultural heritage exists. Yup'ik culture is highly interrelated with the natural environment. Within this environment and the subsistence activities that occur, Yup'ik people have their own way of conceptualizing knowledge, categorizing, and performing everyday tasks. For example, a recent study (Fall, Chythlook, Schichnes, & Morris, 1989) describes a system of categorizing types of Dolly Varden (a fish) by their fat content and function in subsistence living, rather than by a scientific abstraction. The cultural and linguistic system relate to a specific environment; thus cognition and the making of meaning are socially constructed in unique ways, yet share attributes with many other societies (see, e.g., Rogoff, 1990, on Mayan mothers making rugs in Guatemala, and tailoring in Liberia). Yup'ik teachers also use expert apprentice modeling effectively in their classrooms and fish camp (Lipka, 1990; 1991). Fish camps abound with everyday uses of mathematics, from estimating the number of dried fish needed for an extended family for a year–fish racks and fish houses being units of measure–to solving packing problems in order to efficiently fill storage space. For example in fish houses, fish are placed on top of one another with the tails lying on top of heads in alternating rows so that the fish are tessellating, or fitting the surface; fish fit together like a puzzle, thereby reducing gaps. In this example, everyday cognition provides rich and varied opportunities for developing pedagogy that is based within and from Yup'ik culture.

Researchers from cognitive and cross-cultural psychology increasingly view everyday practice in both its social and cognitive functioning as having great relevance for schooling (Lave, 1988; Newman, Griffin, & Cole 1989; Rogoff, 1990). Many researchers (Bishop, 1989; Harris, 1989; Presmeg, 1989; Zaslavsky, 1973, 1985) recognize that different cultural groups have different ways of organizing time, space, and place. These cultural and linguistically situated ways of making sense out of the natural and social world include the underlying worldviews which form the basis upon which mathematics is derived. Only very recently has there been a concerted interdisciplinary effort to work with everyday cognition and culturally-based mathematics and to bring this energy to formal schooling. For example, the Kativik School Board in Northern Quebec has been using Inuktituk language and culture as a basis for mathematics for the past decade (Denny, 1986). More recently, the Mohawk School Board at Akwesasne is developing an aboriginal math and science curriculum and pedagogy. In Alaska, the Ciulistet is an example of Native teachers studying Yup'ik ways of learning to establish Yup'ik curriculum and pedagogy in math and science.

Methodology

The Ciulistet is a voluntary group of Yup'ik teachers who have organized into a study, research, and school change group. Their membership includes elders, bilingual aides, and university faculty (the author). The Ciulistet is a remarkable educational group. It is highly unusual for a group of teachers to persistently work together for 12 years for the purpose of helping their people and providing support for one another. This occurs despite the fact that these Yup'ik teachers live and work in six different villages and the only means of transportation is by bush planes. By its very nature, the group speaks loudly to the underlying and compelling reasons for its existence–responsibility for helping their people by strengthening their language and culture, and bridging their language and culture to schooling.

Social ties and social relations are critical to working in Yup'ik communities. It is only through long-term work that sufficient levels of trust develop to collaboratively explore questions of culture, language, and identity. Twelve years ago I began working with many of the Ciulistet teachers-to-be when I was a field-based faculty member in a University of Alaska Fairbanks teacher education program. During the past 5 years, I have worked formally as consultant to the Ciulistet teachers' group. Over the past year, we have worked on using Yup'ik knowledge of the environment as a basis for mathematics and science education. In addition to the approximately 14 members of the teacher group, we have been joined by at least four Yup'ik elders at each of our five meetings this past year, and nine elders at our final meeting last spring.

The Ciulistet group proposed the research topic and method: investigating the science and mathematics embedded in everyday fish camp experiences. Fish camps were chosen because Yup'ik people still engage in catching and processing fish for the year, and their work groups are still organized in traditional ways. In the first phase, video tapes from the fish camps were analyzed by the group. Our preliminary analysis shows an expert-apprentice modeling of the tasks surrounding fish processing. The youngest members of the family cut their fish independently with an ulu (Eskimo knife), after observing elders and older siblings perform the task.

The next phase of the group's investigation used ethnographic methods such as participant observation, formal and informal interviewing, and linguistic analysis. We were directly instructed by the elders in a variety of Yup'ik cultural activities. During these meetings, elders demonstrated and described various activities, including how they visualized the process of tailoring during the making of parkas and how they navigated under conditions of extremely limited visibility. Gathering Yup'ik knowledge and having elders respond to questions, tell stories, bring in cultural artifacts, and lead "field trips" to forecast weather are representative events of this phase.

The majority of meetings were conducted in Yup'ik, including a five-day meeting held at the University of Alaska Fairbanks. There was a high degree of kinship within the group; Yup'ik teachers attended these meetings with their parents, their husbands, and their children. Group members were well-known to each other or were distantly related. Within this kin-structured context, elders presented their knowledge as gender-specific: the males described hunting and trapping techniques and other subsistence activities, and the women presented information concerning patterns, measurements, tailoring, crafts (such as parka making and their meaning), and storyknifing (see Ilutsik, this volume, for examples of the latter). The elders shared in leading the "seminars." The elders organized the seminars and demonstrations along gender lines following traditional role separation.

During the seminars, three generations were seated within the circle as learning was shared through narratives, demonstrations, explanations, and questions and answers. (University faculty, including the Yup'ik-speaking member, took a background role during these elders' seminars.) The process of gathering information has also become a process of cultural transmission. All members of the group reported that they learned new information, such as how to forecast weather and the meaning underlying parka making and design symbols. During these times, the roles of teacher and learner shifted with topics and specific expertise. Two-way learning occurred, and both Western and Yup'ik systems were valued.

These activities suggested a process of schooling in which elders could work with Yup'ik and non-Yup'ik teachers and aides. For example, elders spent considerable time directly instructing us on how to forecast the weather. Key to their instructions was direct empirical observation of sunrises and sunsets. These activities could easily be transferred to schools by having students step out of the school building. The long Alaska winters make observations of sunrises and sunsets an ideal school-based activity. Similarly, other empirically related phenomena can form the basis for school themes after direct instruction by the elders.

The following sections highlight the processes involved in translating and interpreting from Yup'ik language, culture, social processes, and everyday experiences to obtain a school-based mathematics. Also noted are some of the difficulties encountered in interpreting Yup'ik knowledge to school-based mathematics.

Yup'ik Mathematics

What Is Yup'ik Mathematics?

Numbers are an obvious place to investigate linguistic and cultural ways of representing mathematical ideas. Yup'ik cardinal numbers are presented to illustrate basic Yup'ik number patterns in the base 20 sub-base 5 counting system, and to note the literal meaning of some numbers. The numbers are ordered in a manner linguistically indicated and as shown by elders counting: four sets of five. The literal meanings are noted next to some numbers. Table 1 was adapted from Jacobsen (1984) and from interviews with the Ciulistet and elders.

Table 1

Yup'ik Numbers and Literal Meanings

Cardinal Numbers Counting on one hand	Counting on the other hand	
1 *atauciq* 2 *malruk* 3 *pingayun* 4 *cetaman* 5 *talliman* (one arm)	6 *arvinlegen* 7 *malrunlegen* 8 *pingayunlegen* 9 *qulmgunritaraan* 10 *qula, qulen*	(cross over) (not quite 10) (above)
Counting below on one side (see Note 3)	Counting below on the other side	
11 qula atauciq *12 quIa malruk* *13 quIa pingayun* *14 akmiarunritaraan* *15 akimiaq*	*16 akimiaq atuaciq* *17 akimiaq malruk* *18 akimiaq pingayun* *19 yuinaunritaraan* *20 yuinaq*	(not quite *20)* (the whole person)
Examples of counting beyond *20*		*(20 plus 10)*
30 yuinaq quala *40 yuinaak malruk*		(two times *20*

Yup'ik counting from 1 through 5 begins on the left hand from the smallest end finger, to the thumb, and then crosses over to the other hand repeating this process. To count from 11 to 20, one starts over with the left end finger, and repeats the process. The Yup'ik system is base 20; *yuniaq* represents 20 (literally translated as a whole person). Also, elders at the workshop represented counting materials such as sticks in bundles of 20s. This knowledge of numbers is readily accessible to all Yup'ik speakers. For Yup'ik non-Yup'ik speakers it is cultural heritage. Further, the literal meaning behind the numbers is still accessible to Yup'ik speakers--*arvinlegen* (six) means "cross over," *qula* means "above," and *yuinaq* derives from *yuk* the "whole person,"

which adds meaning to numbers and counting.

Problems of Developing a Yup'ik Mathematics

One problem encountered in counting was the use of two words for 11 *(qula atauciq*–10 plus 1). This represents a modern Yup'ik way of counting 11, while *athaktok* is a precontact method as indicated by ethnographic records (Nelson, 1899). Another problem was that Yup'ik cultural members could not be expected to know the meaning behind words such as *qula* (10, but the literal meaning is above-above what?), just as we would not expect an English speaker to necessarily know the meaning behind 11 or 12. More specifically, Nelson's (1899) description of counting, recorded almost a hundred years ago, differs from modern-day counting:

> As ten is said the two hands, thumbs near together and fingers all outstretched, palms down, are extended a little from the body. Then the right foot is advanced a little and the right forefinger points at the little toe of that foot as the counter says *at-khakh-tok.* This word ordinarily means "it goes down," and is used here both to indicate the descent in counting from hands to feet [acquiring] this connection to eleven. (p. 237).

In this case the ethnographic record makes sense logically, linguistically, and mathematically, but it differs from contemporary understandings.

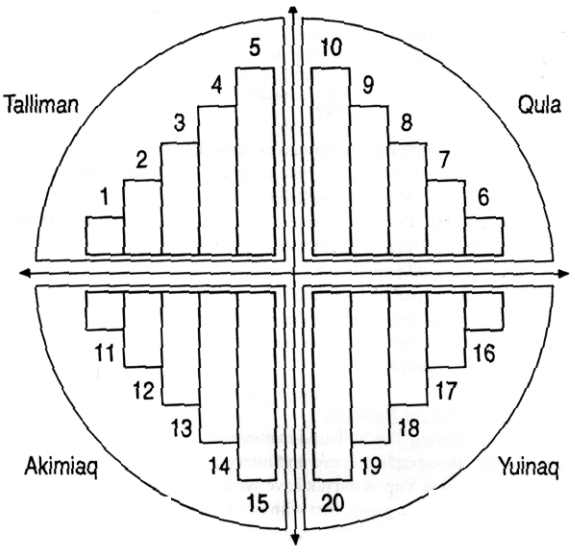
Translating basic Yup'ik knowledge into school knowledge is a difficult and nonlinear process. Taking a concrete contextualized counting system into the classroom, formalizing its operations, then making it abstract is to change the very nature of the indigenous activity. Further, the systematic Yup'ik worldview and knowledge–part of an aboriginal context–no longer exist in that form. Instead, knowledge is becoming increasingly fragmented from its context and its cultural bearers. Knowledge also is not written down but is remembered differently by different people.

Deriving Symbol Set for Numbers

The problem of deriving Yup'ik-based mathematics was further complicated by the fact that the ethnographic record and interviews with Yup'ik elders during our meetings show that Yup'ik did not have symbolic representation for the number systems. Working as a group, first with two faculty members and two Yup'ik research assistants, we analyzed the counting system as a way to work through the problem of representing numbers, particularly regarding the meaning of "11." Using the body to represent the counting system suggested a division of the body into four quadrants with a vertical and horizontal axis. To assist us in visualizing the system we placed and traced our hands on one-by-one centimeter graph paper to represent one through 10. Then we rotated our hands 180 degrees, forming two sets of hands. Both hands placed above *(qula)* represented 10 and the lower hands (or feet) represented 10 more. This procedure is also in alignment with the way Yup'ik numbers are ordered linguistically, as noted earlier.

Next we traced the outline of the hands and this formed four arcs representing 20 *(yuinaq)* or the whole person. We used Cuisenaire rods instead of hands and formed four sets (each set represents sub-base 5) of 5. Further, we noticed that the pattern formed by using Cuisenaire rods in descending order from a five length to a unit length created a pattern that is often used in Yup'ik baskets (see figure 3). We thought that this might be purely coincidental, or it might show the symmetry in the body that Yupiaq used in creating their mathematical system. Figure 1 shows Yup'ik counting to 20 with sub-base 5 in evidence, placed on an axis, and also shows a common Yup'ik pattern. The use of a circle on an axis is an excellent mnemonic for counting. One of the Yup'ik research assistants stated, "I would have learned to count in Yup'ik a long time ago if I learned this in school."

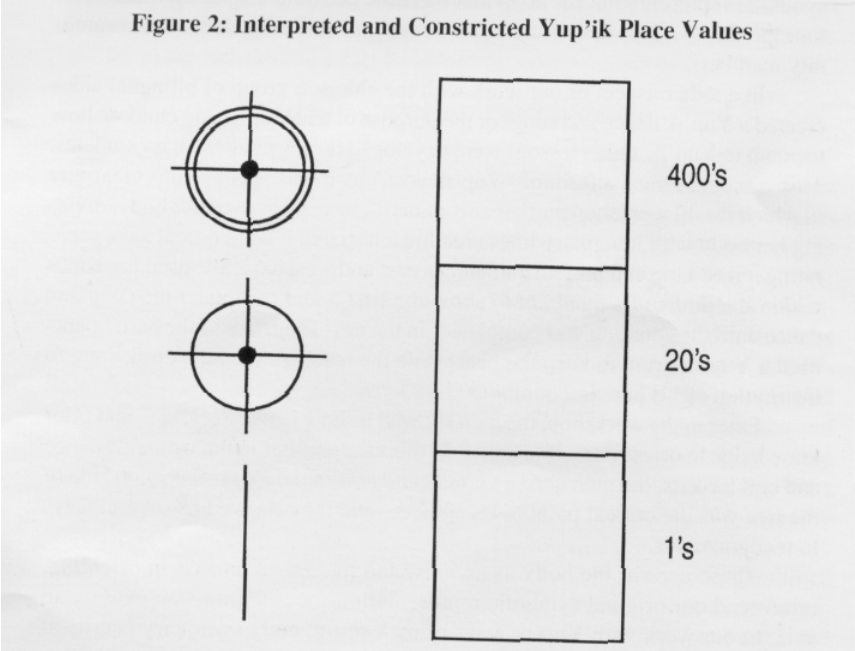
Figure 1: Representation of Yup'ik *Counting, from One to Twenty*



Creating Place Values

To create a systematic way of working with place values, we consulted the Mayan and Egyptian systems as a frame of reference (Closs, 1986). Since the Mayan system is similar to Yup'ik (base 20 and sub-base 5), the Mayan system was chosen as a model for a Yup'ik place-value system.

We also referred to Yup'ik cultural artifacts and Yup'ik ways of orienting in selecting symbols for numbers. We decided to use a circle since it approximated Yup'ik drums and is used in masks, and it appears that *yuinaq* (the whole person) could also be reflected as a circle (a whole). In addition, it was decided to place the circle on a grid to further represent sub-base 5. For the place values, we simply used tick marks for units, one oval on an axis for 20, and two ovals on an axis for 400 (400 being the highest precontact number that is noted in the ethnographic record–see Nelson, 1899; Denny, 1986). Figure 2 shows this symbolic representation.



Approval of the Elders

During our most recent week-long workshop, elders were introduced to the interpreted symbols and their representation. The elders debated the acceptability of these symbols. They debated differences in Yup'ik dialects from one sub-region to another as well as possible mistakes in the Yup'ik orthography and spelling (Jacobson, 1984). The elders engaged in long discussions on the Russian influence of their numbers and the variety of ways of counting past 400. For example, one elder stated, "It seems that counting up to 1,000 can be reached using exclusively base 20 rather than *tiisitsaaq* [Russian loan word] 1,000." After some further discussion, the elder asked another elder "[Can you] count using base 20, it's 500? How would you say half of a thousand without using the word *tiisic* [1,000]?" After awhile the elder replied "Half of a thousand, *tiisicaam avaga*, is included in Yup'ik counting system." This discussion highlights the fact that Yup'ik counting today is "pure" between 1 and 400, and is strongly influenced by Russian culture and language in counting past 400 to more than 1,000. In other words, Yup'ik counting is base 20 up to 400. Beyond 400 it uses a modified base 10 system, using 1,000 as a unit. Hence, 500 is obtained by halving a 1,000.

Most importantly for this work, the elders tried out the place-value system and used the symbols that we suggested. Elders separated sticks into bundles of 5 and grouped those bundles of 5 into fours forming 20s. When counting past 20, elders continued to group 20s in groups of five, using their fingers as place holders. An area of much debate concerned the singular, dual, and plural forms used in Yup'ik to express one 20 *(yuinaq),* two 20s *(yuinaak),* and three or more 20s *(yuinaat).* Despite some of the difficult work of the group, one elder stated that he felt he could learn this system, meaning that the place-value system made sense to him. There was a tacit acceptance shown by the fact that different elders worked with the symbols and the place-value system during the course of the week. However, further discussion is needed prior to adopting this symbolic representation for 20 in that there are possible Yup'ik spiritual overtones to this symbol which may cause dissonance for some elders and community members.

In another aspect of our work with the elders, a group of bilingual aides created a Yup'ik dance and song for the purpose of teaching young children how to count in Yup'ik. Other lessons were developed for lower elementary students. This session seemed a form of "Yup'ik jazz," as it was spontaneous creativity in which the 40 workshop participants joined. The teacher used her body, dividing her body with imaginary lines creating a horizontal and vertical axis, separating it into a top and bottom half and an east and west axis. She used her hands within the limits of a quadrant to show the first 5 and continued the song and dance until the

counting was completed. In the next song, one of the participants used a Yup'ik drum to keep the beat while the teachers sang a Yup'ik song to the rhythm of "Where is Thumbkin?"

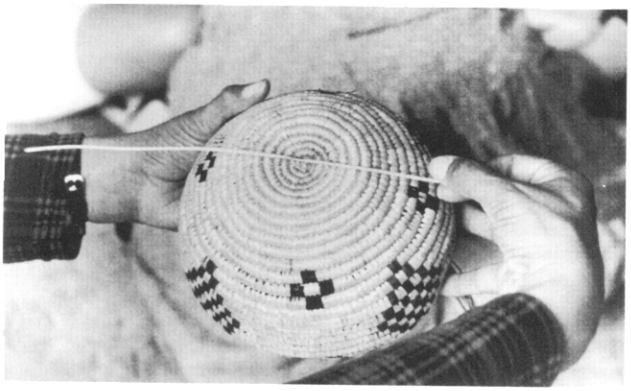
Later in the workshop, the men showed us how to use trees, sun, and prior knowledge to orient oneself to home. In this case, similar to the women's dance and coil baskets, the men used a vertical and horizontal axis– the south side of the tree was the critical point to recognize–and they showed us several ways to recognize this.

These uses of the body as an axis, and the use of an axis in orienting, reinforced our original symbolic representation for counting–an oval on an axis. In our work with Yup'ik ways of measuring, body symmetry is critical in measuring and estimating. While using some Yup'ik measures, we immediately noticed that the length of our span, the tip of one outstretched arm to the other, was equal to a person's height. Yup'ik also use the elbow to the tips of the fingers as another measure, equal to one fourth of a person's height or one fourth of a person's outstretched arms. Further, the width of a hand is another measure; it equals a fifth of the elbow-to-fingers measure. In other words, it was five hand-widths to one elbow-to-fingers measure (sub-base 5), and since this is one fourth of the height, it was 20 hand-widths to the person (base 20 = one person). Coincidental or not, body symmetry, sub-base 5, adds to the original idea of representing the counting system on an axis as a means of representing the sub-base and the whole.

Polar Coordinate Geometry

While observing women making grass coil baskets during the workshop, one of the faculty members placed a string along the center or starting point of the basket with the string intersecting the placement of the designs the women were sewing into the basket (see figure 3). From a mathematical perspective, the women were using polar coordinate geometry as a means of making coil baskets and keeping track of where the designs should be placed. For example, from the center point on a 45-degree angle at X distance along a radial, a design would be placed. Further, measurements using grass straw or other material would be made to figure out proportionate placement of the design around the basket. Figure 4 shows a top-down view of a spiral and polar coordinates. In addition to these ideas, other mathematics and science curriculum and pedagogy can be developed. A few other examples follow.

Figure 3: Symmetry in a Grass Coil Basket



Patterns

Pattern identification is an important part of beginning geometry. A number of ethnomathematicians and math educators (Harris, 1989; Zaslavsky, 1973) interested in multicultural education and the importance of everyday cognitive experience suggest that basing and building from local patterns is one excellent way to develop mathematical understandings. One approach emerging from the week-long workshop was the use of Yup'ik colors as organized in beading designs. Beading patterns were simply made by ordering the four Yup'ik colors in a distinct pattern. One Yup'ik teacher suggested putting a beat, by using a Yup'ik drum, to each color and to

the pattern. One teacher suggested "the drum beat is so [she begins tapping]. . . . It's like a heart beat, so I guess you could use [it] as a guide and rhythm [continues tapping] to beading." This distinctively Yup'ik way of teaching simple patterns integrates Yup'ik cultural forms with the Western mathematical idea of patterns and sets.

Recurring patterns in parka borders are right triangles, rectangles (rotated and straight), the plus sign, and circles. Often these shapes are embedded within each other, and sets of shapes can be viewed on multiple planes. It is just this type of pattern recognition that some math educators are suggesting can assist students in problem-solving, particularly as related to geometry.

Another example is in the geometrical patterns used throughout a parka and the critical connection between these patterns and the stories they tell. In Western thinking, these patterns represent critical connections between literacy and numeracy, as the patterns themselves are stories, and exact placement is required for the story to be accurate.

Discussion

This article shows some of the fundamental ways in which we are collaborating with Yup'ik elders, communities, and teachers to explore their own Yup'ik language, culture, and folkways as they consider what should be included in schooling. The next section highlights some theoretical implications for schooling in indigenous contexts, and describes the process of culturally negotiated schooling.

Developing Culturally-Based Mathematics

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 aboriginal and Western systems. Connecting aboriginal system of numbers and measurements, using hand and feet for counting and measuring, to the decontextualized abstract system of mathematics can demystify mathematics. Mathematics in its decontextualized form bears little resemblance to its more concrete beginnings. Yet within Yup'ik language and culture, concrete connections to estimating abound. These concrete manifestations of mathematical processes can form the basis from which mathematics is developed. Students will see that mathematical systems have evolved from the concrete to the abstract, are based on familiar patterns and ways of ordering, and relate to concrete and cultural symbols.

However, the premise that the Yup'ik language contains mathematical concepts, particularly numbers, and is accessible to all Yup'ik speakers is more complicated than expected. As noted earlier, up to the number 400, the Yup'ik system, using base 20, can satisfactorily generate all numbers. Yet the strong influence of the Russian language and culture adding numbers over 400 using a base 10 system alters Yup'ik counting and access to Yup'ik counting today. Further, the influence of English and base 10 has made it the dominant means of counting to the point that elders had to confer repeatedly on the correct way of counting in Yup'ik. This led one experienced Yup'ik teacher to say, "This is the way we want to go with our language. Speaking [it] correctly in our language and understanding them [numbers] in the correct form." Additional confusion arose from the Yup'ik linguistic system and its forms for singular, dual, and plural. Despite these difficulties, and perhaps because of them, the entire group engaged in a serious discussion of the right way to express numbers in Yup'ik using the Yup'ik system of counting. Although the Russian system added and blended with the Yup'ik system of counting and the English language and base 10 have effectively replaced Yup'ik counting, the elders and the participants were eager to count properly in Yup'ik.

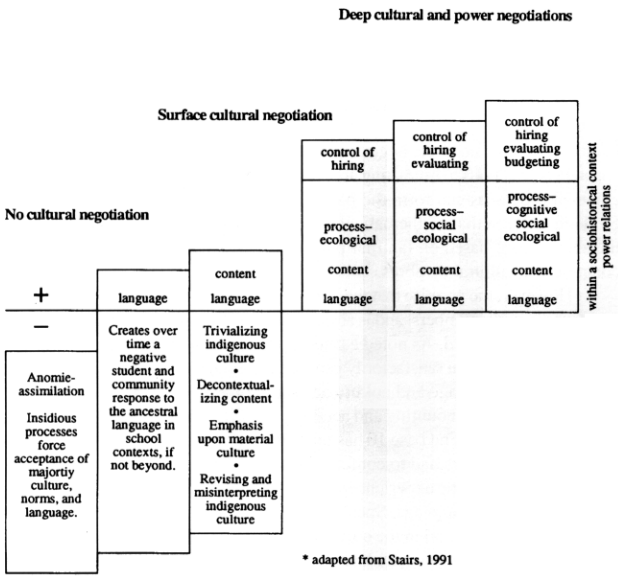
Our approach to constructing curriculum and pedagogy offers an alternative to the either-or proposition of traditional Western schooling versus traditional indigenous culture (see Figure 5, adapted from Stairs, 1991). Most importantly, this third way is changing the context of schooling by valuing Yup'ik language and knowledge and by providing an opportunity for elders and the school community to visualize the possible

ways in which everyday tasks and knowledge can be a basis for learning in school.

Developing Theory

Grounding and developing theory from the work presented in this paper suggests an alternative to the structural (Ogbu, 1987) and cultural (Jordan, 1985) explanations for differential minority school performance. The structural theory does not provide adequate direction for school change, short of society becoming more equitable. However, to the degree that schools are a microcosm of society, then the extent to which schooling can be transformed parallels that to which a community can transform society. In essence, these micro-level changes have ripple effects.

Figure 5: Culturally Negotiated Pedagogy



Simultaneously, theories of cultural compatibility underestimate the variability and choices being made by minority and indigenous communities and present overly simplistic views of cultural compatibility and incompatibility (Cummins, 1986; Jordan, 1985). The evidence for this lies in the fact that some linguistic minority communities want the language of instruction to be English while others opt for their own language; some want schooling to represent their culture while other groups want schooling to teach the dominant society's "secret language"--the language of power. (For details and examples, see Harris, 1990.) Simple cultural compatibility does not adequately account for this diversity within and across minority and indigenous groups.

During the last decade some indigenous schools and communities have begun to view schooling as a tool to resolve the dual dilemma of being both modern and indigenous (e.g., Watahomigie & McCarty, 1994; Watahomigie & Yamamoto, 1987). Emerging across cultural groups and national boundaries are alternative ways of constructing schooling, from Maori "language nest programs," to Inuktituk math programs. Research, practice, and dialogues with colleagues (Lipka, Harris, Mohatt, & Stairs, 1992) in varying contexts has led to considering culturally negotiated schooling as a means of conceptualizing the changing relationship between community and school in indigenous contexts.

From these experiences, the process of culturally negotiating the context, content, and social processes of schooling emerged. This theoretical perspective suggests making visible the various processes and relationships involved in schooling, from micro-behaviors in the classroom to the content and ways of teaching that content. (See Figure 5 for a model of this process; cf Lipka & McCarty, in press.) Cultural negotiation is a

process that makes schools' hidden values and processes visible to community and school while making the community's knowledge, values, and processes visible to schooling. Schooling then becomes explicit and open to choices–choices that can only be responded to at the local community level as they concern issues of culture, language, and identity. Through an exploration of their own cultural strengths and their particular goals and visions for their children, community and school can construct a curriculum of the possible–creatively devising content and pedagogy.

Cultural negotiation implies issues of power and culture. Power and culture are inherent and intertwined in questions concerning whose school it is, whose language, whose values, and whose social processes are included. Indigenous groups' active involvement in responding to these questions promotes a process similar to Freire's (1971) concept of "conscientization," implying awareness and action. Through this process, the school becomes a community institution (Lipka, 1991), making choice available at the community level.

In terms of the case presented here, the next step in our work is to gain further approval, make modifications, and begin implementing these ideas with students. Presently, we are in the process of implementing these ideas with the elders and the Yup'ik teachers and bilingual aides. We are testing these ideas and developing these thoughts with the group. We plan to next involve students to see if these materials, patterns, and culturally based approaches to mathematics make sense to them.

However, the more difficult process of negotiating these ideas and approaches with the general community and the school district remains. Although this approach makes logical sense and is supported by elders and the Ciulistet, the low status of Yup'ik culture and language within the wider society has affected community members and school administrators' perceptions, who view things Yup'ik as irrelevant or even harmful to Western schooling and knowledge. The strategy that the group believes holds promise is showing the community and the school district positive evidence for these approaches. Ways of presenting evidence consist of having community meetings in which these materials and ideas are shared with the community and the school. To accomplish this, we have planned workshops with schools in southwest Alaska. Included in these workshops will be teachers and students, community members, Ciulistet teachers, and elders working with the project. These workshops will explore additional topics such as astronomy from Yup'ik and Western perspectives, deepen our knowledge about current topics, and strengthen our understanding of the sociocultural context for organizing and solving problems. In the future, we hope to take ample time to write curriculum and develop pedagogical approaches for teaching this curriculum.

It will only be through considerable community acceptance that the culture of the school can change. We are simply presenting approaches that can be used both to teach Western content and to reinforce Yup'ik culture, language, and identity. Typically, such approaches have fallen outside of the boundaries of what constitutes schooling. Only through making such propositions visible can the process of negotiating schooling take place.

It is exciting to be involved in a process that includes a community of people who are deriving mathematics based on their experience, their culture, their language, and their common sense. Our hope is that this approach speaks directly to indigenous peoples' calls for schooling to address the dual dilemma of being both modern and traditional.

Conclusion

The processes and products of our approach to negotiating the culture of the school have ramifications far beyond southwest Alaska. Involving the community--in this case Yup'ik elders, teachers, bilingual aides, students, school board members, and university faculty--created a rich working environment in which both insider and outsider knowledge is valued. The long-term collaborative efforts of the university, the Ciulistet, and these communities has allowed for, and is slowly changing, the context of schooling. It is only through years of working together that the group has become increasingly aware of the contributions of Yup'ik teachers and elders. The workshop itself modeled the importance of Yup'ik language by having it as the medium for instruction and discourse. We also valued Yup'ik culture by using it as a base for curriculum content, and we prized Yup'ik social processes by deriving social interactions and teaching methodologies from those

processes.

The long-term collaborative efforts by universities and schools can make a difference in changing some of the fundamental dynamics surrounding schooling--the relationship between context and content (see, e.g., Lipka & McCarty, in press). What is incorporated in schooling as content, as processes, and as values can become more inclusive and reflect diverse interests. Deriving mathematics from Yup'ik language, culture, and everyday experience holds promise for teaching mathematics as well as for reinforcing Yup'ik culture. Creating an atmosphere in which the very essences of schooling are analyzed and worked through with community members, teachers, and administrators can reconstitute schooling in ways that make sense for being both modern and indigenous. This may well hold promise for other groups located far from Alaska.

Notes

1. The collaborative research and the development of Yup'ik pedagogy has been funded by the University of Alaska Fairbank's *Alaska Schools Research and School Improvement Fund* and by a grant from *Eisenhower Math and Science*.

2. Nelson (1899) uses *atkhakhtok* (Nelson's spelling) which literally means "descending," and his description in the text indicates descending to the toes.

3. "Counting below" is derived from the logic of Yup'ik counting as *qula* (the literal meaning of 10 is above), so it is deduced that the next ten are below. The ethnographic record of Nelson (1899) and Denny's (1986) analysis of another Eskimo group's counting lend credence to this interpretation.

Jerry Lipka, Ed.D., is Associate Professor of Education at the University of Alaska Fairbanks.

References

Bishop, A. (1989). Review of research on visualization in mathematics education. *Focus on Learning Problems in Mathematics, 11*(1), 7-16.

Closs, M. (1986). The mathematical notation of the ancient Maya. In M. Closs (Ed.), *Native American mathematics*, (pp. 291-370). Austin: University of Texas Press.

Cummins, J. (1986). Empowering minority students: A framework for intervention. *Harvard Educational Review, 56*(l), 19-36.

Denny, J. P. (1986). Cultural ecology of mathematics: Ojibway and Inuit hunters. In M. Closs (Ed.), *Native American mathematics,* (pp. 129-180). Austin: University of Texas Press.

Fall, J., Chythlook, M., Schichnes, J. & Morris, J. (1989). *An overview of the harvest and use of freshwater fish by the communities of the Bristol Bay region, southwest Alaska.* Juneau: Alaska Department of Fish and Game, Division of Subsistence, Technical Paper # 166 (draft on file in the Anchorage office).

Freire, P. (1971). *Pedagogy of the oppressed* (M. B. Ramos, Trans.). New York: Herder and Herder.

Harris, P. (1989). Teaching the space strand in Aboriginal schools. *Mathematics in Aboriginal Schools Project Series No.4.* Darwin: Northern Territory Department of Education.

Harris, S. (1990). *Two-way Aboriginal schooling: Education and survival.* Canberra: Aboriginal

Studies Press.

Hakuta, K. (1986). *Mirror of language: The debate on bilingualism.* New York: Basic Books.

Jacobson, S. (1984). *Yup'ik Eskimo dictionary.* Fairbanks: Alaska Native Language Center.

Jordan, C. (1985). Translating culture: From ethnographic information to educational program. *Anthropology & Education Quarterly, 16*(2), *105-125.*

Lave, J. (1988). *Cognition in practice: Mind, mathematics and culture in everyday life.* Cambridge: Cambridge University Press.

Lipka, J. (1990). Integrating cultural form and content in one Yup'ik Eskimo class. *Canadian Journal of Native Education, 17*(2), *18-32.*

Lipka, J. (1991). Toward a culturally based pedagogy: A case study of one Yup'ik Eskimo teacher. *Anthropology & Education Quarterly, 22*(3), 203-223.

Lipka, J., Harris S., Mohatt G., & Stairs, A. (1992). Culturally negotiated education in indigenous contexts. Session and papers presented at the annual meeting of the American Anthropological Association. San Francisco, California.

Lipka, J., & McCarty, T. L. (In press). Changing the culture of schooling: Navajo and Yup'ik cases. *Anthropology & Education Quarterly.*

Meriam, L., Brown, R. A., Cloud, H. R., & Dale, E.E. (1928). *The problem of Indian administration.* Baltimore, MD: Johns Hopkins.

Nelson, E. (1899). *Eskimos about the Bering Strait.* Washington, DC: Smithsonian.

Newman, D., Griffin, P. & Cole, M. (1989). *The construction zone: Working for cognitive change in school.* Cambridge: Cambridge University Press.

Ogbu, J. (1987). Variability in minority school performance: A problem in search of an explanation. *Anthropology & Education Quarterly, 18*(4), 312-334.

Presmeg, N. (1989). Visualization in multicultural mathematics classrooms. *Focus on Learning Problems in Mathematics, 11* (1), 17-24.

Rogoff, B. (1990). *Apprenticeship in thinking: Cognitive development in social context.* Oxford: Oxford University Press.

Stairs, A. (1991). Learning processes and teaching roles in Native education: Cultural base and cultural brokerage. *Canadian Modern Language Review, 47*(2), 280-294.

U.S. Department of Education. (1991). *Indian nations at risk: An educational strategy for action.* Final report of the Indian Nations at Risk Task Force. Washington, DC: U.S. Department of Education.

Watahomigie, L. J., & McCarty, T. L. (1994). Bilingual/bicultural education at Peach Springs: A Hualapai way of schooling. *Peabody Journal of Education,* 69(2), 26-42.

Watahomigie, L. J., & Yamamoto, A. Y. (1987). Linguistics in action: The Hualapai bilingual/bicultural education program. In D. D. Stull & J. J. Schensul (Eds.), *Collaborative research and social change: Applied anthropology in action* (pp. 77-98). Boulder and London: Westview Press.

Zaslavsky, C. (1985). Bringing the world into the math class. *Curriculum Review, 24*(3), 62-65.

Zaslavsky, C. (1973). *Africa counts: Number and pattern in African culture*. Boston: PWS.