Introduction

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Guest Editors

Factors that Affect Alaska Native Students' Mathematical Performance

In 1994, we edited a special issue for the *Journal of American Indian Education* (JAIE) which emphasized the struggle to bring "local community based knowledge into the life of the school" (Lipka, p. 2). We stated then that "radical transformation in social context of schooling must also occur... In short, bringing local knowledge into American Indian/Alaska Native education requires reversing historic power relations that continue to separate school knowledge from community knowledge" (Lipka, p. 2). Twelve years later and in collaborating with many Yup'ik elders, teachers, mathematicians, and educators we have developed Math in a Cultural Context (MCC),[1] a supplemental elementary school math curriculum. MCC brings local knowledge into a core academic curriculum and to some extent this process and products are a small step in reversing historic power relations and what constitutes legitimate school knowledge.

The purpose of this special issue is to provide four case studies of teachers effectively implementing MCC in diverse Alaskan contexts. Each case provides plausible explanations for the documented success (Lipka & Adams, 2004; Lipka et al., 2005; Lipka, Adams, Sharp, & Sharp, 2005 in press; Grigorenko et al., 2004) of MCC. These cases build directly on the 1994 special issue of JAIE as each case shows how elders' knowledge was effectively used in the elementary math classroom. We believe that the power of these cases resides in the long-term collaborative work between insiders and outsiders resulting in effective culturally based curriculum.

MCC's use of local knowledge provides a way to close the academic gap and answers Merriam's 1928 call for changes in AI/AN schools and communities to use local knowledge in schooling. This is particularly important when considering Demmert and Towner's (2003) reviews of culturally based education (CBE). These analyses revealed that very few CBE studies produced methodologically rigorous work (the use of quasi or experimental designs, according to Demmert and Towner's criteria). They found even fewer studies that had statistically significant results in favor of the culturally based treatment.

MCC is one of the few studies that meets Demmert and Towner's criteria of being a culturally based curriculum and pedagogical approach that uses rigorous research methods and that has statistically significant results in favor of the treatment. Table 1 summarizes the test results of approximately 3,000 students. Therefore, this special issue adds to the field of culturally based curriculum and pedagogy.

Table 1

Summary Statistics[2]

Title of Curricula and Trial Date	Treatment N	Treatment M	Treatment SD	Control N	Control M	Control SD	Statistic D	Statistic t, F	Effect Size
Fish Racks Spring 2001	*160*	*13.40*	*15.79*	*98*	*2.37*	*15.44*	11.03	t= 5.522*	0.715
Egg Island Spring 2002	*128*	*19.66*	*17.02*	*87*	*13.95*	*16.37*	5.71	t= 2.471**	0.349
Fish Racks Spring 2002	*141*	*14.70*	*17.49*	*142*	*17.18*	*18.95*	-2.48	t=-1.146***	
Egg Island Fall 2002	*203*	*20.69*	*18.30*	*139*	*12.12*	*17.99*	8.57	t= 4.298*	0.477
Fish Racks Fall 2002	*204*	*15.63*	*16.11*	*118*	*6.28*	*16.08*	9.35	t= 5.023*	0.581
Berry Picking Spring 2003	*89*	*21.80*	*21.38*	*32*	*4.27*	*14.45*	17.53	t= 5.129*	1.213
Berry Picking Fall 2003	93	69.35	21.31	152	57.38	18.36	11.98	F=20.006*	0.652
Drying Salmon Fall 2003	84	40.49	15.11	107	32.75	15.97	7.73	F=11.949*	0.484
Parka Patterns Spring 2004	122	53.33	13.11	80	46.78	13.23	6.55	F=11.868*	0.495
Fish Racks Spring 2004	99	55.10	15.99	47	40.69	16.60	14.42	F=24.588*	0.868
Egg Island Fall 2004	88	56.51	16.00	94	50.04	16.05	6.47	F= 7.313**	0.403
Star Navigation Fall 2004	131	68.49	17.91	70	46.05	22.89	22.44	F=51.085*	0.980
Berry Picking Spring 2005	45	44.92	12.15	85	43.31	12.06	1.61	F=27.772*	0.134
Smokehouse Spring 2005	70	47.74	15.92	101	34.77	15.94	12.98	F=25.676*	0.814

NOTES

M and SD are calculated for the gain score (post-pre) as represented by italics (scores above the dotted line).

Otherwise, M and SD are calculated for the post-test scores adjusted by pre-test covariate.

D is the difference in means ($M_{Treatment} - M_{Control}$)

*p ≤ 0.001, **p ≤ 0.01

***Rural treatment vs. rural control was statistically significant with p-value of 0.0008 (means: 19% vs. 8% gain)

Before discussing these cases, it is important to describe the development of MCC.

The Development of Math in a Cultural Context

This collaborative effort arose from the dedication of a core group of Yup'ik elders and teachers who recognized the threats to their cultural and linguistic continuity and viewed MCC as a healthy alternative[3] (G. Moses, Personal Communication, July 26, 2003). Through demonstrations and explanations, this group of elders conveyed cultural knowledge around topics as diverse as how to build a kayak, how to design and sew a border pattern, and how to navigate using the stars. From approximately 1995 to 2002, we held two to three meetings a year with Yup'ik teachers and elders. We joined the elders and teachers in building fish racks and model smokehouses. We also participated in star navigating, collected traditional stories, and games. Over the years we worked together to develop an integrated supplemental math curriculum.

Culturally Based Curriculum

Although we use the concept "culturally based curriculum and pedagogy," it is, in fact, a misnomer. All curricula are culturally based. The key question is on whose culture is it based? In most indigenous contexts in the U.S., curriculum has been based on and imposed by the majority culture (Deyhle & Swisher, 1997).

MCC is also a direct response to the top-down authoritarian ways of teaching mathematics, in which there is one right answer and usually only one way to find it. Associated with the one right answer is a classroom discourse style of the teacher initiating questions about known facts, students responding, and the teacher evaluating students' responses (Cazden, 1986). Through the development of MCC and work with elders and reform-oriented math educators and mathematicians, we have developed math as problem-solving. This is not open ended, but rather guided problem solving in which students are able to be semiautonomous. They "discover" mathematical principles and properties because the curriculum design, mathematical tools, and familiarity with the activities are structured so that students of different abilities and inclinations can learn in different meaningful ways and at different levels.

Because of what the elders and experienced Yup'ik teachers have told us and what we have observed, we have increasingly included expert-apprentice modeling and joint productive activity (Doherty, Hilberg, Epaloose, & Tharp, 2002) as pedagogical strategies. Many lessons begin with the teacher (the expert) demonstrating a concept to the students (the apprentices). Following the theoretical position of the Russian psychologist Vygotsky (1978) and expert Yup'ik teachers (Lipka & Yanez, 1998) and elders, students begin to appropriate the knowledge of the teacher (who functions in the role of expert), as the teacher and the more adept apprentices help other students learn. This establishes a collaborative classroom setting in which student-to-student and student-to-teacher dialogues are part of the classroom fabric. The typical authority structure surrounding classrooms changes as students take on more of the responsibility for learning. Social relations in the classroom become more level. In the case of MCC's modules, the connections between out-of-school learning and in-school learning are strengthened through pedagogical approaches such as expert-apprentice modeling and joint productive activity when those are approaches of the community.

Based on the above, MCC's design included math content knowledge (which is informed by both Western schooling and the knowledge of Yup'ik elders), pedagogical knowledge (which is informed by both school-based practices and ways of teaching, communicating, and learning in Yup'ik communities), and contextual knowledge (ways of connecting schooling to students' prior knowledge and the everyday knowledge of the community). See Figure 1 below.

However, MCC is designed to be an adaptive curriculum, because we do not believe that everyone teaches in the same way or that any one curriculum fits all teachers, students, and circumstances. In 1974 Walker and Shaffarzick (1974) concluded "*not* that the new curricula are uniformly superior to the old ones … but rather that *different curricula are associated with different patterns of achievement*" (p. 97), and it cannot be assumed that it will achieve the same results across different cultural contexts. One must not only examine the limitations of any curriculum when measuring its effectiveness, but must also consider its fit with teachers and students in context. Since we believe that culture and context are critical in the

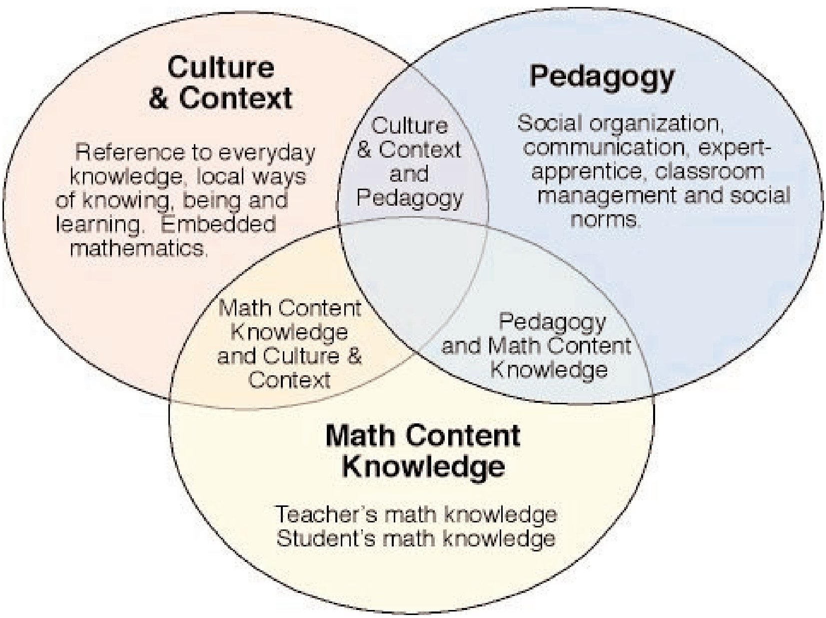

Figure 1. MCC's Theoretical Model.

development of MCC, we therefore believe that the enactment of MCC in different cultures and contexts will differ. How it differs across cultures and contexts is one of the features of this special issue. Each case is distinctly different from the next. Sometimes the differences are between novice and experienced teachers, sometimes between urban and rural Alaska, and sometimes between Yup'ik, Athabaskan, and Caucasian student groups. These cases attempt to tease apart these cultural and contextual differences and, through detailed qualitative analysis, find common factors across the cases that identify factors that make a positive difference in Alaska Native students' math performance.

Each classroom case provides a careful analysis of the interaction of MCC curriculum with teachers, students, and the local context. Our purpose is to identify the factors that may positively affect the performance of Alaska Native students and the conditions and circumstances in which MCC works.

General Methodology

All the cases were selected from a larger body of data. Key selection criteria included teachers that had a better-than-average improvement in their students' outcome measure (gain scores derived from project pre-tests subtracted from posttests). Through classroom observations, we identified classrooms where (a) students were highly engaged and communicated mathematically, (b) problem-solving was in evidence, and (c) connections were made to the local context. Videotape analysis was our prime method of analyzing classroom interactions. Segments were identified, translated into English when needed, transcribed, and placed on Transana (http://www.transana.org/), a powerful video analysis tool. Through Transana, keywords were generated and scenes of high engagement or of interest to the researchers were put into a series.

To guard against cultural bias in the video and analysis and interpretation (Smith, 1999, pp. 177-178), a group of Yup'ik retired teachers joined the faculty and helped analyze the tapes. On a few occasions elders analyzed the tapes along with Yup'ik teachers and researchers. Insider perspectives were essential for understanding many of the interactions taking place in the classroom and how they related to local cultural norms. Thus, we are attempting to establish a Yup'ik-oriented framework for viewing effective teachers of Yup'ik students, and we are still developing our theoretical and interpretive framework. Beyond this culturally specific interpretive framework, we are also interested in differences across cultural contexts. Thus the methodology of long-term and ongoing analysis is akin to the long-term and ongoing processes of developing the curriculum. The whole process occurred in a cyclical fashion. Curriculum development was followed by implementation, which was followed up by analysis, followed by revisions, and so on.

Guiding the Interpretation: Insider Views

One result of the collaborative approach to classroom analysis was a beginning frame for understanding the beliefs and insights of experienced Yup'ik teachers into what makes a classroom environment supportive of Yup'ik and other students' learning. To establish this interpretative framework, we viewed a cross-section of videotapes with the Yup'ik cohort. The group identified a non-threatening classroom environment as an important factor. They also noted the importance of the relationships between the teacher and the student and between the students.

Visible behaviors such as working together, "going down to their level," and not forcing the students were some of the insights shared. In the community, they said that elders teach when you are ready. Evelyn Yanez, a retired Yup'ik teacher, noted: "We don't force people to do things. For example, if someone were forced to do something when that person was not ready, in a subsistence activity involving water travel, people might drown." Evelyn continued,

> It's the same with teaching. You don't force kids to learn. If they want to learn they can learn. That's one of the number one rules in our Yup'ik culture. You don't force people to do things if they are not ready.

That was true for Evelyn, when she was teaching in the classroom:

> When I was teaching, I would begin teaching the whole class. Then the ones that were ready to learn would learn from me what I was teaching. These kids that learned would then become teachers of the other kids in the class when they were ready to learn. So, even though I started with the whole group, only those who were ready to learn, learned; and then they became teachers to the ones that weren't ready when I was teaching the lesson to the whole group[4] (E. Yanez, Personal Communication, October 17, 2005).

Allowing students to have ownership of their learning was mentioned as very important. This idea of ownership was related to how elders teach others by giving away their knowledge so others can learn. According to Evelyn Yanez and Dora Andrew Irke, both retired Yup'ik teachers, "Elders give their knowledge to us [Native teachers], and then we share what we learned from them with others."

The idea of harmony was also mentioned as very important. In the Yup'ik idea of harmony meaning is negotiated among those participating in the learning and a consensus is built around a common understanding. So, even though participants may have differing views, they are all working toward the same goal—coming to a common understanding that is "good for everyone in the community as a whole." This idea of consensus is what Evelyn Yanez speaks to when she says that the goal is for "our minds to become one so that everyone will understand." Yanez also pointed out that elders often say to the group they are talking to, "If I make a mistake, please correct me"[5] (E. Yanez, Personal Communication, October 17, 2005). This is because the end goal is for everyone to come to an understanding for the good of the whole. These types of insights would not have been possible from a single cultural perspective. These insights shaped the analysis of the cases and the cross-case analysis.

The Specific Case: Getting at Classroom and Contextual Factors

The specific cases about implementing and unpacking the successes of MCC occur across a spectrum of contexts. The first case describes a novice teacher, Stacy Clark, who teaches in a Yup'ik school district that in the past did not perform well on statewide math assessments. However, when Clark used MCC, her class outperformed all others. Webster, Wiles, Civil, and Clark attempt to explain how this novice to both the community and culture and to teaching accomplished this highly significant achievement.

In the second case, Lipka, Brenner, Sharp, and Sharp examine how Nancy Sharp, an experienced Yup'ik teacher, implemented a MCC module that was "in her blood" and how she effectively combined both Yup'ik and Western pedagogical practices. This case explores in depth how she created a "third space" for productive classroom learning.

In the third case, Adams, Adam, and Opbroek present the case of a teacher (Opbroek) with six years of experience. Opbroek teaches a group of students with mixed ethnicity, in an Athabaskan region of the state, on the road system in a small town an hour out of Fairbanks. Central to this case is the question of how MCC will work with a group of students from another cultural group. Also, salient is Opbroek's ability to engage her students in consistent and productive mathematical communication while using Yup'ik cultural knowledge of star navigation.

In the final case, Rickard writes about a long-term Fairbanks teacher who has consistently produced strong gain scores while using MCC. Typically a third of this teacher's classes over the years are Alaska Native students. Rickard examines the key question of how Janet Speed, the teacher, adapts MCC to make it effective in an urban context and what specific mathematical and pedagogical strategies she uses to get consistent gain scores.

Endnotes

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[2]Table 1 lists the summary statistics for 14 trials conducted between the spring of 2001 and the spring of 2005. In each case the sample size, average, and standard deviation is shown for both the treatment and control groups. Further results presented include the difference in group means (D), the statistic of interest (t or F), and the effect size calculated by dividing D by the standard deviation of the control group. Prior to fall 2003 to test differences among means of the groups we used the gain score (pre-test subtracted from post-test) and performed analyses using a standard t-test at the student level. Starting in fall 2003 we used a modified post-test score adjusted using pre-test covariates and carried out analyses of covariance at the student level using fixed factors of urban and rural. In all but one trial, we found statistically significant results with a variety of effect sizes, most at a medium to strong level.

[3]Comments by G. Moses during a Summer Math Institute. Fairbanks, AK, July 26, 2003.

[4]Comments by E. Yanez during a Story and Literacy meeting. Fairbanks, AK, October 17, 2005.

[5]Comments by E. Yanez during a Story and Literacy meeting. Fairbanks, AK, October 17, 2005.

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