Making Math Count: Tribal College Leadership in Education Reform on the Northern Cheyenne Reservation

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Recently, representatives of Chief Dull Knife College (CDKC), the tribal college of the Northern Cheyenne Nation, took new actions to assert sovereignty in relation to reservation schooling. This case study presents an account of these actions, which illustrate the kind of resistance that Hall and Fenelon suggest is possible in tribal college settings.[1] Specifically, as a result of math curriculum reform at CDKC, not only has student success in math increased substantially, but some important unintended consequences have occurred: Northern Cheyenne student identities have been strengthened, college teaching practices incorporate more culturally relevant strategies, and the tribal college has assumed a new leadership role in the improvement of instruction for Cheyenne students in local school districts.

This study takes as its starting point the idea presented by Thomas Hall and James Fenelon that tribal colleges can be important sites of resistance to the dominant culture as they engage in activities that enhance tribal culture

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and society.[2] Stein describes tribal colleges as "small tenacious institutions of higher education that serve the smallest and poorest minority group in the United States (American Indians) under difficult and challenging circumstances," while being "under-funded, overworked, and viewed by the rest of American higher education with some wonder at their ability not only to survive, but to survive with panache."[3] Tribal colleges differ from nontribal two-year colleges by incorporating tribal language, cultural learning, and specific curricula that address the needs of American Indian nations. This essential cultural component contributes to the unique purposes of these institutions to "combine personal attention with cultural relevance, in such a way as to encourage American Indians—especially those living on reservations—to overcome the barriers in higher education."[4] They assist American Indian students, who previously may not have related well to the educational process, by building closer relationships with faculty, easing the pressures of education, and preparing them for transition to a four-year institution.[5]

In Hall and Fenelon's view, tribal colleges offer opportunities for indigenous communities to create their own ways of addressing important problems, such as educational barriers, by drawing on traditional cultural resources.[6] While earlier approaches often linked traditional practices with obstacles to development, more recent views move away from such simplistic assertions, emphasizing both the roles of tribal organizational actors and the contexts in which they pursue development. For example, the work of Champagne, Ward, Snipp, Hall, and Cornell and Kalt has suggested that traditional cultures (e.g., customs, values and ideologies) provide important resources for the direction of social changes desired.[7]

While "tribal sovereignty" may seem to be a contradiction in terms to many who consider its implications in the context of the contemporary United States political economy, it remains a significant pursuit for American Indian nations that continue to struggle for a greater measure of influence, if not control, over their political, economic, educational, social, and cultural development. The Northern Cheyenne Nation of southeastern Montana has asserted its political sovereignty numerous times over the last several decades and is known for its successes. In these instances, sovereignty pursuits have been concerned with the protection of natural resources of the tribe—land, coal, water, and timber—as well as Northern Cheyenne education and culture. Education continues to be an area in which tribal sovereignty efforts are being pursued. The purpose of this paper, therefore, is to first explore tribal college students' experiences with the math curriculum reforms from 2004 to 2011 and the meanings they give to these changes, especially as these relate to their attitudes toward college and aspirations for the future. A second purpose is to examine how the solutions the tribal college has implemented in math have

contributed to recent sovereignty efforts of Cheyenne educators to assert more influence over educational practices in reservation schools.

The Research Population

The Northern Cheyenne Nation was established on a reservation in southeastern Montana in 1884. The Northern Cheyenne Nation includes roughly 6,000 members, about 4,500 of whom live on the reservation. Nearly 40 percent of Northern Cheyenne families have incomes below the poverty level, which is important to consider in light of today's gas prices and the remoteness of the Northern Cheyenne Reservation (about one hundred miles from an urban center).[8] Unemployment fluctuates between 60 and 85 percent since jobs are scarce.

About 42 percent of the reservation residents are under the age of eighteen, and another 50 percent are between the ages of eighteen and sixty-four. The median age of twenty-one among the Northern Cheyenne has important implications: young Northern Cheyenne have access to relatively few elders—the keepers of Cheyenne knowledge—who can act as mentors.[9] Yet research has shown that traditionality and knowledge of the Cheyenne ways correlate with educational success.[10] Nevertheless, only about half of high school students attend college shortly after they graduate, and the high school dropout rate ranges from 40–60 percent among local K–12 schools;[11] the recent CDKC graduation rate is less than 20 percent of sophomores;[12] and fewer than 11 percent of adults have college degrees,[13] compared to 17 percent in Montana and over 15 percent in the US.[14] Such low completion rates in higher education do a great deal to convince Northern Cheyenne youth that they cannot succeed in an academic setting, let alone contemplate an academic career. A dearth of role models adds to the discouragement of Northern Cheyenne students who are often the first generation (88 percent of CDKC students in 2011) in their families to pursue a college education.[15]

The proportion of Northern Cheyenne who speak and/or understand the Cheyenne language has been declining. Recent data from the CDKC Student Enrollment survey show that about one-quarter to one-third of new tribal college students speak or understand Cheyenne.[16] This parallels a trend in the community in which fewer younger people can speak Cheyenne. Like other tribes, the Northern Cheyenne have responded to this development by establishing a cultural heritage center that sponsors programs in Cheyenne language, history, and culture from the Cheyenne perspective.[17] The cultural resources of the college are now being utilized to increase Cheyenne language fluency among CDKC students and to offer new sources of information on Cheyenne history and culture to the reservation community.

These resources support a unique aspect of the curricula offered by Chief Dull Knife College, a two-year institution fully accredited by the Northwest Commission on Colleges and Universities. As a community-based, tribally controlled college and land-grant institution located on the Northern Cheyenne Indian Reservation, its open-admission policy offers to the Cheyenne and their neighbors opportunities for liberal arts and career education. Originally chartered in 1975 by tribal ordinance, the college opened in 1978 and offers associate of arts and associate of applied science programs, as well as certificates in several areas.

CDKC's enrollment averages between 200 and 300 students per semester, about 95 percent of whom are American Indian. Placement tests for CDKC students indicate a substantial need for remedial instruction: more than 90 percent test below the skill level needed to enroll in college algebra. In communication arts, more than 40 percent of students test below the college level. Because students must complete several developmental skills classes, they typically take several semesters to complete their freshman year and at least three years to graduate. The average number of students graduating each year from 2008 to 2011 was twenty-three.

Literature Review

American Indian Education

Historically, many have assumed that the problems in American Indian education were attributable to individual incompetence.[18] Although a number of researchers have critiqued these assumptions, others have pointed to several important aspects of student experiences that affect their school completion, such as lack of preparation, poor experiences with schooling, and cultural incongruities between students and schooling.[19] In reservation communities, school quality often suffers and graduation rates tend to be low.[20] Due in part to a history of governmental policies that have isolated the reservations socially and economically—a history that Snipp summarizes as transitory from "captive nations" to "internal colonies" —these communities continue to struggle with poverty, poor health conditions, poor educational opportunities, and a lack of labor market opportunities even for those with college degrees.[21] These factors suggest reasons for poor student motivation in the academically demanding studies of math-related fields, especially when the benefits in such areas seem minimal, or at least less apparent.

Elements of school contexts also contribute to the problematic schooling experiences of reservation students. In particular, relationships between students and instructors, as well as the expertise of instructors, are critical

aspects of learning.[22] Recent research on Northern Cheyenne schools shows that, among a number of factors, high turnover rates among instructors and administrators create serious disruptions.[23] Instructors' inexperience and training in math and science are also obstacles to positive student learning experiences. Therefore, even students with interest in math-related studies often find it difficult to access the instructional resources they need to succeed.

Cultural incongruities—between conventional teaching styles and traditional teaching practices among American Indians—also may contribute to difficulties in math learning. Deschenes, Tyack, and Cuban suggest that a "mismatch" takes place between the "problem" student's background and the school's structure.[24] As Hale noted, "Cultural orientation . . . continues to influence the learning and perceptions of American Indian students."[25] Because so many primary and secondary instructors of American Indian students are non-Indian, cultural differences are a likely challenge in the communication of information and interaction between instructors and students.[26]

Several studies, however, suggest that improving education for minority students is not simply a matter of creating a generic "minority-compatible education structure," but rather one of addressing specific cultural needs. Culturally relevant pedagogy promotes academic success, the students' cultural integrity, and critical consciousness.[27] The school failure that American Indian students often experience is what Deyhle describes as "a rational response to irrelevant schooling, racism, restricted political, social and economic opportunities, and the desire to maintain a culturally distinct identity."[28]

Ballantine also argues that minority student experience is largely influenced by external factors such as labeling.[29] Well before the college application years are at hand, students generally have been labeled at some point along the success-failure continuum by instructors, parents, counselors, even peers. Since about 80 percent of American Indian students attend public schools with a majority of non-Indian instructors and students, the opportunities for labeling abound.[30] Such labeling often leads to tracking that may conflict with student ability and aspirations, and contribute to poor preparation for college.

As Ballantine explains, "Many minority students who enter college fail to complete their degree work, not because of ability level, but because of poor academic preparation and campus climates."[31] Even with sufficient preparation for college, the college experience can be difficult for minority students, who may feel that peers and professors are constantly searching for indications of their "inferiority."[32] Success or failure in schooling pursuits, as well as labeling or stereotyping, can have important negative effects on student confidence and identity as students. These experiences can also play a role in shaping minority students' ethnic or racial identity.[33] Perspectives on racial and ethnic identity formation provide useful concepts for understanding this process.

Ethnic Minority Identity and School Experience

Taking a constructionist approach, Cornell and Hartmann describe identity formation as an interaction between assignment and assertion, the constant interplay between the group identity assigned by the majority group and the identity a group asserts about itself.[34] This process does not have a distinguishable end: "Ethnic and racial identities and the groups that carry them change over time as the forces that impinge on them change, and as the claims made by both group members and others change as well."[35]

The identity-formation process for minority students often includes group stereotypes and negative views of behavior or capacity. For example, minority students are frequently tagged as academically inferior.[36] Thus, majority groups not only influence minority students by assigning them to a minority category, but they also suggest the *content* of that category.[37] Garroutte's research shows the importance of multiple influences on American Indian identity, both internal—local traditional culture, for example—and external, such as legal influences.[38]

Challenges in Higher Education

The identities of American Indian students continue to be shaped by their school experience as they move into higher education. The impact of poor preparation can be seen in that 30 to 50 percent of American Indian students drop out of high school.[39] Thus, American Indian students are among the least likely of any ethnic group to enroll in college.[40] According to US Department of Education figures for fall 2011, American Indians had the next-to-lowest level of college enrollment among all racial and ethnic groups.[41] Fewer than 40 percent of American Indian students who complete high school matriculate into any type of postsecondary education.[42] For those who do enroll, college completion rates are lower than for most other groups at both two-year and four-year institutions.[43] While historically college attrition rates have ranged from 75 to 93 percent, attrition rates for American Indian students have declined recently as graduation rates have increased.[44] Reasons for attrition are both academic and sociocultural.[45]

Importantly, Ballantine insists that "the picture is not all bleak" because "tribal colleges are meeting the needs of many students."[46] The American Indian Higher Education Consortium currently reports thirty-seven tribal colleges and universities in operation.[47] These institutions offer culturally relevant academic instruction that helps to overcome the education barriers many students face in reservation communities.[48] While Hall and Fenelon suggest that tribal colleges may become sites for the pursuit of tribal sovereignty,[49] Cole's research comparing historically black colleges and tribal colleges

indicates how this may occur: tribal colleges are ten times more likely to offer culturally oriented courses.[50] Brayboy asserts that research on American Indian higher education should address how sovereignty and local approaches to knowledge, culture, and power are pursued within these contexts.[51]

Challenges in Learning Math among American Indian College Students

Among the challenges that tribal colleges face are the low levels of academic preparation among American Indian students, especially in math, an area of study these students are often discouraged from pursuing.[52] Research shows that instructors advise American Indian students to avoid majors that require math due to perceived lower ability levels.[53] In the 1970s, Green, Brown, and Long found that "the factor most important in keeping Indian students from obtaining a good mathematics education is the prevalent feeling among instructors, counselors and administrators that a more-than-rudimentary mathematics competence is beyond and/or irrelevant to Indian needs."[54] Low academic expectations for American Indian students continue to be problematic today.[55]

However, research also suggests that other factors influence American Indians' decisions to avoid math classes. Cultural resistance to math may shape students' educational choices and career paths across generations as well. Parsons, Adler, and Kaczala found that students whose parents believed math was difficult passed this belief on to their children.[56] Studies also show that students who do not take advanced math courses are severely limited in their career choices and earning potential.[57] Students with negative attitudes toward math are less likely to experience economic success as they self-select into majors that do not require advanced math courses.

Math Anxiety

Research on math anxiety suggests that this phenomenon is one of the most prevalent emotional problems associated with low academic achievement levels in math. Gender and age are also important factors correlated with math anxiety, with women experiencing more test anxiety and men more anxiety about math tasks.[58] Hsiu-Zu Ho and colleagues found that math anxiety negatively affects achievement, causing students to perform at lower levels on math tests. This was found to be true across nationalities and genders.[59] Therefore, as students experience high levels of math anxiety, they are less likely to experience achievement in math courses. Low achievement in math courses can be a source of math anxiety as well, resulting in a cycle of academic failure and discouragement. Math anxiety is also inversely related to students' positive perceptions of math.[60] Hembree found that students who experience

math anxiety not only have negative attitudes toward math, but are also more likely to avoid taking math courses and even discuss the subject of math.[61]

Instructors' attitudes and methods affect students' levels of math anxiety. Wenglinsky's analysis shows the significant impact of instructor preparation on classroom activities and student achievement.[62] Williams found that math anxiety is generally derived from instructors and their math teaching methods, and students usually do not have math anxiety before attending school.[63] Research by Turner found that students were afraid to ask for help when instructors displayed even a slightly negative attitude about the students' abilities.[64] Concerning possible remedies, Clute's research showed that students with high levels of math anxiety improved their performance when instructors used mastery-based teaching.[65] Finally, Collins found that black students learning algebra through computer-assisted instruction experienced less math anxiety than with conventional instruction.[66]

Curricular Reforms: The Mastery Approach

Recent research indicates the utility of an alternative approach known as mastery learning, structured instruction that allows students opportunities to acquire basic skills through modeling, as well as both guided and independent practice.[67] The mastery learning approach involves four dimensions that influence the quality of instruction: cues or directions provided to the learner, participation of the learner in the learning activity, reinforcement relating to learning objectives, and feedback or correction. To be most effective, instructors should tailor instructional cues to meet student needs and reach as many students as possible. In small settings, instructors can work individually with each student. Oral and written assignments are often used to ensure student participation in learning activities, and instructor feedback targets areas where students need additional instruction and practice.

Several studies support the effectiveness of the mastery approach,[68] although others show little advantage to this method.[69] While some researchers report the greater effectiveness of structured, mastery-based instruction, Schereens asserts that teaching effectiveness is best conceived as falling on a continuum of structured and student-centered, or "open" approaches.[70] Recent research also shows that the need to improve math skills among new community college students, estimated at 60–75 percent of new students, has led to greater use of computerized, mastery-based instruction.[71]

CDKC's Mastery-based Math Program

In response to student needs in both math and science, in 2004 CDKC administrators and faculty initiated the adoption of a mastery-based approach for its

math and science courses. The math program reforms, funded by a National Science Foundation Tribal Colleges and University Partnership (TCUP) grant, allow students to complete pre-college math credits at their own pace using a computer-guided instructional system coupled with individual assistance from instructors, more relevant applications, and tutors and other support services. The interactive computer program also provides students with opportunities to use technology that will be relevant as they transfer to other college settings.

At CDKC, success in math courses has been shown to be central to student retention and graduation.[72] Student success in the pre-college math courses is influenced by several key factors: student preparation for college-level math, placement, out-of-class support, and promotion based upon demonstrated mastery of basic skills, as opposed to secondary-level social promotion of students. To address these problems, CDKC improved its math-placement test to better identify the skill levels of each student. Using this assessment, students with remedial needs are placed in basic mathematics, introductory algebra, and intermediate algebra. Only after *demonstrating* mastery of the content of each course at a level of 80 percent or above can a student proceed to college-level math courses.

Several math faculty were involved in reorganizing instruction in the developmental math courses. Previously, CDKC's pre-college courses provided instruction through lectures and required students to obtain an average of 60 percent to pass. Lectures were progressive, building on the preceding lectures, and course grades were based on a variety of activities such as homework, quizzes, tests, and projects. Thus, missing one or more classes—a problem for many tribal college students—resulted in an increasing disadvantage for math students since they had to master the material missed in addition to new material. Students with weaker math skills found it difficult to learn the content they missed, and then often experienced frustration, more absenteeism, and even failure.[73] In contrast, the new self-paced, computer-guided approach to the three pre-college math classes began with the following key features: courses included nine chapters of progressively challenging material covered in a course text and through the computer-based program; students had access to computer hints, video tutorials, and worked examples; and students were required to pass a computer-based assessment at 80 percent in order to receive credit for completion.[74] Monitoring the implementation of this new program led CDKC faculty and staff to initiate additional innovations designed to facilitate student success; for example, capping math class size at twelve students and reorganizing and strengthening the tutoring program. CDKC also created a learning center staffed by tutors and math instructors that gave students additional resources and time to work on math. Importantly, to reduce the number of withdrawals and failures, CDKC math instructors also restructured

developmental math course credits: credit was assigned to each section of the course, and students could enroll in a one math credit at a time, rather than enrolling in a traditional three-credit course. Additionally, as an incentive to continue, students who completed a credit during a semester could enroll in another credit free of charge.

Research Questions, Methods, and Data Sources

Research questions for this case study concerned the experiences of CDKC students in the new mastery-based program, the impact on student attitudes and feelings, and how the new program related to traditional Cheyenne ways of learning and efforts of the college to provide leadership to local schools.

A research team, comprised of both Native and non-Native members who have many years of experience with this community, collected qualitative data, including both classroom observations and interviews that explored student experiences with the math program. More than two dozen interviews were conducted with students participating in the new math program from 2006 to 2009, as well as math faculty and staff. Topics for student interviews included attitudes toward math learning; experiences with the math program and related resources; sources of support for schooling; interactions with peers, family, and instructors who influence school experiences; and aspirations for future schooling. Interviews were conducted at the tribal college in locations that would allow for privacy. The purpose of the research was explained to students, and they were invited to participate in confidential interviews with members of the research team. Pseudonyms were assigned, and research team members transcribed and coded the interviews.

Although the student interviews are the focus of this paper, data from surveys completed by a non-representative sample of students enrolled in the CDKC math classes in 2007–2008 and 2008–2009 also provide evidence for a larger number of students concerning student attitudes and experiences related to the math program. This survey instrument, developed for the formative assessment of the NSF TCUP project, obtained student feedback on new instructional activities that were used by faculty to adjust teaching strategies and monitor student attitudes.[75] The survey was developed through collaboration between TCUP project evaluators and CDKC math faculty and included both general questions about student attitudes towards math and specific questions that gauged student reaction to the different elements of the math curriculum reforms. The descriptive statistics for survey responses suggest some short-term effects of the new pedagogical tools developed through the project. Additionally, developmental math course completion and withdrawal rates presented for

academic years 2004–2011 provide an overview of math course outcomes associated with implementation of reforms during the TCUP project.

The indigenous evaluation framework developed by the American Indian Higher Education Consortium (AIHEC) with support from the National Science Foundation (NSF) provided support for the methodology.[76] This framework recommends including data from all groups that have a stake in a program. Of particular importance is the use of different types and sources of data to *tell the story* of a program in a way that accurately represents the interests, values, and views of the community. This approach is compatible with grounded theory techniques and utilization-focused evaluation as well as Garroutte's approach to the study of Native identities and Brayboy's call for attention to sovereignty and culture.[77]

Research Findings

Overview of Math Course Completion Data

Figures shown in table 1 reveal that in the initial stage of program reforms (2004–2006), students' developmental math course completion rates increased substantially: from 47 percent in 2004–2005 to 80 percent in 2005–2006. However, figures for 2006–2007 and 2007–2008 show subsequent declines in math completion. Consequently, new assessment data collection focused on discovering problems and determining the kinds of improvements needed. Several critical changes in the pre-college developmental math courses—such as goal-setting by students and curriculum adjustments—substantially improved student experiences in math classes, confidence in their skills, and math credit

Table 1
CDKC Developmental Math Course Enrollment, Completion and Withdrawals by Academic Year, 2004–2011

Academic Year	# Students Completing*	% Students Completing*	# Student Withdrawals	% Student Withdrawals	Total Enrollment
2004–2005	47	47%	49	49%	101
2005–2006	122	80%	20	13%	152
2006–2007	125	68%	38	21%	184
2007–2008	98	47%	35	17%	210
2008–2009	134	69%	22	11%	193
2009–2010	184	66%	39	14%	279
2010–2011	183	67%	39	14%	271

* Note: Completing refers to passing courses with a grades of A, B, C or P.

completions. Decreases in withdrawals from developmental math courses, also shown in table 1, provide additional evidence of the positive impact of these changes along with increases in math course completions.[78] For example, the percentage of students withdrawing from developmental math courses decreased substantially, from 49 percent in 2004–2005 to 14 percent in 2010–2011.

Additional data (not shown) on developmental math course completion within four years for four cohorts indicate an important effect of the changes implemented: the rate of basic math credit completion (of total credits attempted) increased from .51 for the 2006–2007 cohort to .73 for the 2008–2009 cohort. Data for other developmental math courses show similar improvements, indicating that these courses are no longer the stumbling blocks they once were, and that students are able to proceed more quickly to the college-level courses.

Interviews: Addressing the Challenges of Learning Math 2004–2006

Individual student and faculty interviews in the early years of the project provide more details about the experiences of students with the challenges of learning math and the new CDKC mastery-based, interactive, computerized math program. Almost all of the students interviewed felt they learned math more effectively through the individualized computer and mastery instruction than with the previous lecture-based model. "Math's fun. I really hated it in high school, but now I like it," explained one student in basic mathematics.[79] An older student, who came to CDKC for a GED and continued on for a college degree after having dropped out of high school, reiterated those feelings: "I love the new math system here, and that's coming from someone who used to hate math!"[80] Overall, the new math program—combining mastery-based instruction and flexible credits with support from student services, the learning center, and math tutors—appeared to have the desired effect of improving student experiences with math and reshaping their attitudes. Most interesting, however, was learning why the new math program appeared to work so well.

CDKC's decision to implement mastery-based math was influenced by prior experiences with science instructional reforms that had positive results. Therefore, even though the faculty did not know *exactly why* this approach had worked in science, they hoped that using the same method could also strengthen math. Reflecting on past experience, one male student noted, "Everyone had trouble with math when I was growing up. Lots of people didn't like it—I liked it. Why didn't they like it? Maybe it wasn't taught right."[81] What is it about the new, multifaceted mastery approach that comes closer to teaching it "right?" Interview data suggest several reasons.

Many students mentioned that the self-paced, flexible features of the math program accommodate their lifestyles and lift the pressures of learning math.

Students reported that often they were unable to work on homework assignments immediately after class because they had to care for their children; according to CDKC enrollment survey data, almost half of CDKC students have at least one child. Being able to work on assignments at any time and from any location with an Internet-connected computer provided a greater sense of freedom and control. The "flexibility" of the program also included its flexible credit system, in which students were able to enroll in a single credit of a math course and add credits as they completed them through the semester. As noted above, the 2005–2006 and 2006–2007 school years showed marked improvement in the course completion rates. Much of this was due to the flexible credit system, which allowed students to work at their own pace rather than falling so far behind that withdrawing or failing seemed to be their only options. When interviewed about the early program reforms, one math instructor stated, "having flexible credits makes a lot more sense than having a whole bunch of W's [withdrawals]."[82] A student interviewee mentioned, "I like the self-paced system of math computer courses—I do better at my own pace. It takes the pressure off."[83] This comment endorses Knutson and McCarthy's finding that imposed time limits may discriminate against American Indian students whose cultural traditions emphasize the care and consideration put into a response, rather than the speed of its delivery.[84]

The Cultural Fit of the New Math Program

Though not a central reason that CDKC staff initiated the new math program, its effectiveness fits well with the traditional Northern Cheyenne ways of teaching and learning—hands-on experience mentored by elders, which promotes student mastery and independence. One instructor referred to this increased independence as the ability for students to "control their destiny" to a greater degree.[85] When students are puzzled about their computer problems, they can push an "instruct" or a "hints" button, or ask a tutor or instructor for additional assistance. They also have greater access to out-of-class assistance than before. This allows students to hold as much of the instruction process as possible in their own hands. One student, commenting that "[the new math program] fits in well with the way I was brought up to learn," discussed how the self-paced mastery system paralleled the traditional way she learned during her upbringing.[86] Reflecting on a moment when math lessons finally "clicked" because they fit the traditional pattern of learning from her childhood, another student observed, "I think that math could be more enjoyable for everyone if we had moments like that, of learning math on our *own* terms."[87] For this student, math on her "own terms" meant learning in a cultural style that was a world apart from the imposed system of math education she experienced in

secondary education. These students' experiences resonate with Nelson-Barber and Estrin's assertion that "mathematical ideas and culture are inseparable."[88]

CDKC's mastery-based math program accommodates cultural differences in other ways as well. One faculty member explained that, "There is a 'cultural inhibition' that prevents many [Cheyenne] students from asking for help, even when they really need it in math."[89] Deyhle recognized a similar "inhibition" among Navajo youth, illustrated in the comments of one interviewee:

> The way I see it seems like the whites don't want to get involved with the Indians. They think we're bad. We drink. Our families drink. Dirty. Ugly. And the instructors don't want to help us. They say, "Oh, no, there is another Indian asking a question" because they don't understand. So we stop asking questions.[90]

Even if this perception is not reinforced at tribal colleges, by the time students arrive at college it is most likely ingrained deeply enough that the "cultural inhibition" has become a cultural norm. This was a serious setback under the previous system, in which students often found themselves left behind in class lectures, yet unable to take the necessary steps to catch up. One student explained how difficult it was to gather the courage to approach CDKC math faculty, based on previous experiences with math instruction:

> I went to my teacher and said, "I am really embarrassed to say this, but I am not good at math. I don't understand it." When I went to school, they just passed me through, because with my generation, they didn't care what we learned. So, when I was in the eighth grade, I was still using colored bears to count.[91]

Addressing Math Anxiety and Increasing Confidence in Math Skills

With the new math system, students can spend additional time on sections where they may have weaker understanding and speed through sections that are easy for them. Because this system frees instructors from much of the class lecture duties, they are able to be more aware of student needs as they work individually and provide one-on-one assistance, rather than waiting for students to raise their hands during a lecture. Students also receive personalized attention in the learning center outside of class hours, which adds more flexibility by giving them the latitude to work with a variety of instructors and tutors. In interviews with CDKC math instructors, there was a consensus that the changes in the way math is taught increased their ability to gauge student needs and progress. One instructor noted: "Under this system, even if it's not faster, I have a very good feeling for what it's doing to make math stick and to raise student confidence in math and change their attitude toward math."[92] Another instructor observed, "Students who are actually interested in getting somewhere are making great progress under this system."[93] CDKC

math faculty expressed the hope that even those students who were not yet interested in their math coursework will see their peers' accomplishments in this "hardest subject" and increase their motivation.

This increase in math confidence mentioned by the math instructor above is an important commentary on the program's positive effect on student attitudes. Other faculty members observed that students in the new math courses seemed to display greater confidence in their ability to look at problems analytically, rather than blaming mistakes on their inability to understand math. One instructor explained, "They're changing their reactions to a wrong answer from, 'I'm not good at math—I can't do this!' to saying, 'If it's not right, why isn't it right? Why is the computer saying 'no'?'"[94]

Student interview data confirm this progress. One student who previously had struggled a great deal in math asserted, "In the past, I didn't like math because it was so confusing. But now I like it because I can understand it. It took my math confidence up."[95] This student's instructor, who also taught her math class in high school, recalled, "She's asked me more questions in the past two days [at CDKC] than she did in a month in high school."[96] Like others interviewed, this student became more open to asking questions about math because she had more confidence in her ability to seek, understand, and apply the information she received—the very antithesis of math anxiety.

Needs for Continuing Program Improvements, 2007–2008

In the early years of the new math program, students also mentioned several challenges. Some students indicated that more structure in the CDKC math program, such as individualized goals and timelines, would help them stay on track and graduate on time. Being "on time" is a particular concern for students who must finish their coursework before their eligibility for financial assistance ends. In 2007–2008, additional interviews with faculty and students confirmed the continuation of some previous challenges that students faced and also identified new needs or problems. For example, although many students liked the computer program, at least a third of the students continued to struggle with math courses. Interview data presented in the following sections from interviews conducted in spring and summer 2008 identify several types of obstacles that these students faced.[97]

Student-instructor interactions. Some students had concerns about the extent to which instructors took their learning needs seriously, respected their effort, or were truly available to help them. Examples of such comments include the following:

- I feel like whenever we ask [him/her] for help, that [he/she] gets frustrated that, "Why didn't you get it when I just showed it to you?" We need to know that [the teachers] care about us.

- Someone needs to take the time and say, "Listen, you're not stupid."
- Most people here are intimidated by the teacher. Instead of asking if you need help, they wait for you to say something.
- When I finally talked to [the teacher], I said, "I sat here all last semester, and I'm stuck." He said, "Whenever you are stuck, just tell me." He showed me all the times that he was in class and other times when I could come and ask for help.

Classroom structure. Some students also had concerns about the need for more structured math instruction, as expressed in the following comment: "The program needs more structure. There needs to be deadlines and due dates. Say to a student, this week you need to have 5.1, 5.2, 5.3, etc. done, and really expect them to be done."

Individual histories. Students' previous experiences with math and schooling as well as current family responsibilities also affected their engagement with classes. For example, one student explained, "It's been ten years since I've been out of school, because of things that happened to me in my life, and I am finally able to go because my kids are old enough for me to go. I mean, I'm a single mom, I have five kids to raise on my own, and I don't live with their Dad, I haven't had an easy time."

Student motivation. Some students were concerned that instructors underestimated their motivations to succeed and to show others—family, friends, and community members—that they could do well in math. Examples of their concerns are illustrated by the following quotes:

- I want to be an inspiration to other people, to have them look at me and say, "Hey, if she can do it, I can do it."
- When I was younger, I used to have to take my daughter to my mother's and sister's house when she had math homework, and I had to watch as my sisters would explain it to her, and now I can do that for my son. I saved all my notes from that class, and I'm planning on pulling them out, and showing my son, "This is how my teacher showed me." I'm even grateful to have them even as a reference, so I can go back to them. I'm going to keep it forever. I'm going to keep it so that I can show my son how to do math. . . . I want him to learn early, because I was left behind. I don't want him to ever feel how I have felt.

Based on the new assessment data, faculty considered several recommendations to address the students' challenges. These included improving knowledge of students' ability levels; using proactive approaches to engage students; expanding the teaching tools, such as mini-lectures, visual aids, and the like; increasing monitoring of student progress toward goals they set; offering

cohort-based classes that would meet four days a week; and establishing a math learning center where students could work on math any time.

New Strategies for Addressing Math Challenges 2008–2011

During this phase of the math program reforms, math faculty initiated several new strategies to enhance the math program and class structure: asking students to establish their personal math course goals and timelines, which were reviewed weekly; additional time mentoring students; providing mini-lectures, especially on concepts related to numeracy; and spending office hours in the learning center to help tutor students. Courses that included small cohort groups that met four days a week also provided more continuous math instruction for students who identified this need. Curriculum adjustments included incorporating more locally relevant math problems. The results of these efforts can be seen in improved math credit completion rates.

Following the adjustments made to the developmental math program, student responses reflected the efforts made to address the problems identified. For example, the following five quotes from student interviews show that students liked some changes made, such as more proactive teaching; a four-day class; an evening class; individualized help; and a more goal-oriented class structure with timelines set by the students.[98]

- [The instructor] explains everything very completely, so if I have problems, I can even email [the instructor] too. Then [the instructor] will answer during the next day, but usually I'm back in class anyway, so . . . I think [the instructor] complements the program.
- [The instructor] does things that help the [computer] program teach you and [the instructor] does different ways of visualizing the problem, which is helpful since you know, Native Americans are visual people. [The instructor's] teaching style, ya know, it works for me.
- Yeah. It seems to me that I need [the math class] four times a week, because any less I would forget the concepts that I learned.
- So I think the evening class has been good for me, cuz there's not that many in the class now so we get more one-on-one with [the instructor].
- [The instructor] started giving us. . . like a timeline. . . And like right now, I think it really helps, where I made myself start doing more.

Although some students continue to want more improvements in the accessibility of the computerized program, the majority of students appreciated the recent changes made, which they believed contributed to their progress and success in the math classes.

Math Class Survey Responses 2008–2009

While the data presented in the previous sections indicate important themes among the student interviews, the CDKC math class survey data offer additional indications of the general patterns in student experiences with the revised math classes and program.[99] Starting in spring 2007, the math class survey included questions about student experiences with the computerized math program used in the math seminars. Survey responses for 2008 and 2009 (N=159) provided limited but interesting evidence that the vast majority of the pre-college course respondents liked using the computer program—they used the feedback, tutorials, and hints—and more than half reported the program helped them understand mistakes. At least two-thirds reported that they especially liked the freedom to work on the math program whenever they wanted, and they liked being able to take tests until the answers are at least 80 percent correct. Responses also indicated that some students experienced challenges with the program: about one-quarter to one-third of the students said the certifications and tests were difficult to do on the computer. About one-third of the respondents reported they would prefer to use textbooks; they needed more help from instructors and tutors; and some wanted more lectures.

Additionally, 30 percent of respondents reported that their math class was less difficult than they expected, and 90 percent said they felt "somewhat" to "very comfortable" with math. Along with these positive experiences, large percentages of students reported confidence in discussing math with others (70 percent); helping family and friends (68 percent); understanding math equations (75 percent) and doing math equations (77 percent); solving word problems (60 percent); and completing homework assignments (70 percent) and tests (81 percent) on time. Students also reported feeling confident in majoring in math-related fields, exploring math careers, attending graduate programs in math, and teaching math.[100]

Effects Beyond the Math Classroom: Implications for Identity

While the main purpose of the reforms in CDKC's math program was to improve student experiences with and achievement in math, the case study data show an interesting and important unanticipated consequence: the positive effects extended beyond the math classroom. For many students, math had been a major obstacle to graduation. Therefore, increasing confidence in their ability to tackle this subject affected confidence in other areas. For example, one student reported more confidence in asking teachers for help:

> I like solving problems on my own and didn't like asking for help. But after working with [my tutor in the learning center], I have an easier time with that. Now I go at lunchtime when I can. Yeah, I think working with [my tutor] opened the door for me to ask for help more and get it.[101]

For many CDKC students, the increased ability to achieve in math has also been accompanied by a change in the scale of their aspirations. One student, for example, explained how her entire outlook on the feasibility of education—and whether or not it even applied to her—changed through her experiences breaking down the math barrier at CDKC. Coming from a background of negative math experiences—being told by middle school instructors, "If you can get into a high school that doesn't require math, you *might* be okay"—this student entered CDKC's mastery-based math program apprehensively. However, the self-paced system eased the pressure of learning, giving her the leeway to step back and realize something important: "I love cooking and crafts, and anyone who does those things *already has* to do math—realizing that helped me see that math isn't something scary from a distant universe. It's not separate or unnatural for us to understand. Hard, but very doable."[102] Creating an environment in which students have such epiphanies—to see themselves as not only math-capable, but to realize that math has always been an important and inherent part of their lives—may be the subtle strength behind CDKC's new math program. Being able to see math as a tool rather than a barrier has led this student to consider a wider range of goals as "possible." She has set her sights on a doctoral degree, dramatically shifting her mindset from before, when she "didn't think there was a chance of these goals, even though I was interested."[103]

This student's increasing desire to pursue higher education and the confidence to do so was not unique; many students voiced similar aspirations and hopes. An older student stated that "conquering" math expanded what she felt she was "allowed" to dream about, and others discussed the goal of earning a graduate degree. Many discussed their desire to gain an education and pursue careers—in education, pediatrics, engineering, nursing, and other fields—and return to their community to help improve the standard of living for the Northern Cheyenne Nation. Some students discussed wanting to learn more about their heritage, to help revitalize cultural education and assist the tribal government. One student explained the local need for people with strong educational backgrounds and a sense of efficacy, people who "know the needs of the tribe."[104] Like the students that Brayboy writes about, these college students also see how the college skills and credentials they are acquiring will help them achieve their dreams and, in the future, serve their tribal community.[105] In this case, the college has developed new strategies for supporting these goals.

Conclusions and Implications for the Tribal College

The questions for this paper began with the experiences of CDKC students in the college's new math program. Quantitative and qualitative data collected

within an indigenous evaluation framework provide multiple views that tell the story of the math program. Student and faculty experiences offer valuable insights into the meanings of the revisions to the math program and how CDKC is creating new solutions to meet student needs. Especially important are the ways in which curricular reforms began to close the gap between the students' needs and learning styles and the faculty teaching strategies.

Student interview data indicate that the new courses and resources developed through the TCUP project provided them with new ways to successfully learn math skills, which increased their confidence. Thus, previously held stereotypes about the Cheyenne not being able to do math, described as though this were a fundamental element of what it means to be "Cheyenne," are changing. More students at CDKC are coming to view it as "normal" or, at the very least, *not abnormal,* to succeed in math.

The new program has also reduced math anxiety by alleviating some of the causes, such as the pressure of falling behind in class, the stress of learning through a system that is dissonant with cultural ways in which students are accustomed to learning, the inability to ask questions and receive much-needed assistance, or the fear that difficulties in math could be simply the result of personal incompetence. CDKC's math program also demonstrates that implementing a teaching style and student support services that take culture into account—accommodating the way many students were "brought up to learn"—can improve student experiences with learning.

Though the math-curriculum reforms focused on improving math achievement, the effects of student experiences in this program go beyond math or even school. When students discuss a shift in attitude from "hating math" to feeling that math was "fun," this is far more than a commentary on their confidence in mathematics skill. It tells the story of CDKC students redefining their identity as students and as Northern Cheyenne. These students have adopted a new outlook in which it is conceivable to be both math-capable *and* Northern Cheyenne. Additionally, experiences with their math accomplishment have led some students to consider career paths that previously looked like exclusive toll roads. Consequently, math program improvements contributed—in unexpected ways—to both academic success and positive identity construction among American Indian students.

Using Cornell and Hartmann's social constructionist framework and Garroutte's analysis of Indian identity dynamics, these case study findings support the assertion that identity formation *is* indeed ongoing, and this process is influenced by specific contextual elements and dynamics. In addition to math curriculum changes, other contextual factors that contributed to improved students' academic skills and confidence, as well as identity changes, include the cultural resources of the tribal college, such as the Cheyenne language

program and the cultural center as well as Northern Cheyenne staff who facilitated improvements in the math program.[106] CDKC is actively sending the message to students that the Northern Cheyenne can "do math," have math-related careers, and successfully work for their community, a dramatic departure from the message many students received previously. Importantly, the case study data show that students themselves acted as a force for reversing negative stereotypes, resolving in their favor the tension between externally imposed influences and local cultural sources of identity. Like the students in Andrade's recent research on American Indian women attending a large university, these tribal college students experienced validation of their ability to do math and to become successful college students.[107]

This research also supports previous studies showing that having a strong traditional identity can positively affect academic achievement and retention.[108] It further affirms the claim that low academic confidence impedes minority education, that labeling often negatively influences confidence levels as well as students' ethnic identities, and that students with high levels of math anxiety can benefit from mastery-based pedagogy and computer-assisted instruction.[109] Finally, this study is consistent with research asserting that institutional settings and everyday experiences, including perceived successes and failures, shape students' academic experience and ethnic identities.[110]

Understanding the program impact and dynamics for students also involves attention to the interaction between key actors in this setting—students and faculty. The primarily non-Native faculty, who had previously used mainstream teaching strategies, adjusted their approaches using the resources of the TCUP project. In particular, in building on mastery learning and mentoring, as well as more structured approaches developed for the science courses, math faculty chose to use an interactive, computerized math delivery system as part of an approach that could address the wide range of remedial skill needs among CDKC students. Although this approach was initially effective for the majority of students, it was significantly enhanced when Northern Cheyenne tutors and instructors contributed new strategies that successfully addressed the needs of students who continued to struggle with math skills. This included developing mentoring relationships that allowed students to feel free to ask questions and seek help. At tribal colleges, coordination of student support services with the academic program is critical, since most students enter college with significant academic skill needs. Thus, having the Department of Student Affairs help to facilitate the new math program was essential in ensuring its success. Although not formally part of the project, ideas from faculty—both Native and non-Native—for developing teaching strategies that are more congruent with Cheyenne traditional teaching practices resulted in greater student engagement

with math. These experiences led to greater confidence among the math faculty in their abilities to effectively teach Cheyenne students.[111]

Implications for Tribal Sovereignty: Tribal College Leadership in Cheyenne Education

The data presented above tell the story of the positive effects of math program reforms for students enrolled at Chief Dull Knife College. The reforms provide an excellent example of how a tribal college setting can support the development and application of traditional indigenous cultural views and practices in contemporary education. However, the story of the math program as a form of resistance to dominant educational structures is not complete. New data from recent interviews show that the effects of math program reforms now extend beyond the college to other schools serving the Northern Cheyenne. The new developments involve recent actions by CDKC administrators.

Using assessment data for the TCUP program to obtain feedback and track improvements in student math skill levels, CDKC administrators have become increasingly concerned about the skill levels of students graduating from local schools and enrolling at the tribal college. They have also developed greater confidence in the ability of the college to provide meaningful math and science instruction. CDKC administrators recently made a decision to share their concerns about math instruction through a new forum called the Circle of Schools, which includes the superintendents of local school districts serving Northern Cheyenne students. Working proactively on shared schooling problems, the organization of the Circle of Schools is reminiscent of the Council of Forty-Four, the traditional governance structure of the Northern Cheyenne, which included spokespersons from each of the bands of the Northern Cheyenne Nation. Actions taken by the Circle of Schools to date include workshops for parents, faculty, and staff working in the four local school districts and tribal college. These workshops provide information about Northern Cheyenne culture and history, Native American learning, and teaching that will support effective teaching in the local schools and community.

The leadership shown by CDKC in these efforts has placed the tribal college at the helm of development of the local educational institution for the first time in the history of Chief Dull Knife College. The approach used by Northern Cheyenne educators in the formation of the Circle of Schools supports traditional cultural priorities to care for and socialize their children and to share information or knowledge that benefits the community. In its new leadership role, CDKC is creating its own form of resistance to the educational practices of the dominant society. By offering teachers alternative teaching

practices that originate in or support Cheyenne culture, the tribal college is helping to create new avenues for Northern Cheyenne cultural practices and knowledge to become institutionalized in the local schools. These new practices also establish links to the Northern Cheyenne language and history curriculum at CDKC and the cultural resources developed by CDKC for use by tribal college students and members of the reservation community.

These developments have begun to shape the way community members perceive math and science instruction today. In the past some community members viewed math and science as both inaccessible and potentially incompatible with cultural values. They were particularly wary of the uses of math and science in ways that could be destructive of their reservation land and way of living. Now, when they see the tribal college emphasize math and science to benefit and support tribal goals and priorities, they are beginning to see the potential value of math and science for the reservation community.[112] This can lead to a more supportive climate for instruction that relates positively to Cheyenne interests, values, and traditional teaching strategies.

The educational changes developed by Chief Dull Knife College support Hall and Fenelon's and Brayboy's contention that tribal colleges can be the sites of cultural revitalization and resistance.[113] In this case, the social and cultural capital of the tribal college and its administrators were used to create a new vision of education that is more closely linked to the culture of the Northern Cheyenne community. This vision, which gained the support of other educational administrators and community members, provides the foundation for new efforts to improve local teaching and learning.

As suggested by Richard Littlebear, CDKC president, these efforts resemble the efforts undertaken by the early leaders Chief Dull Knife and Little Wolf to return to their homelands in Montana, whose vision was "about determination, about providing those who followed them the opportunity for a better life in their homeland. Chief Dull Knife College has accepted this vision as part of its missions and continues to, as Chief Dull Knife said, 'Learn this new way of life'. . . a way of life, that even today is constantly changing."[114]

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