A Need for the Project

Need: To improve the mathematics performance of AN students

This three-year proposal responds directly to the long-standing achievement gap between Alaska Native (AN) students and their mainstream counterparts as noted by the U.S. Department of Education (Grigg, W., Moran, R., & Kuang, M., 2010). Further, National Assessment of Educational Progress (NAEP) data shown in Figure 1 highlights the large math gap facing AN students. In fact, the data indicate that AN students are trending lower whereas the other groups are static or improving. AN average score was just 213.

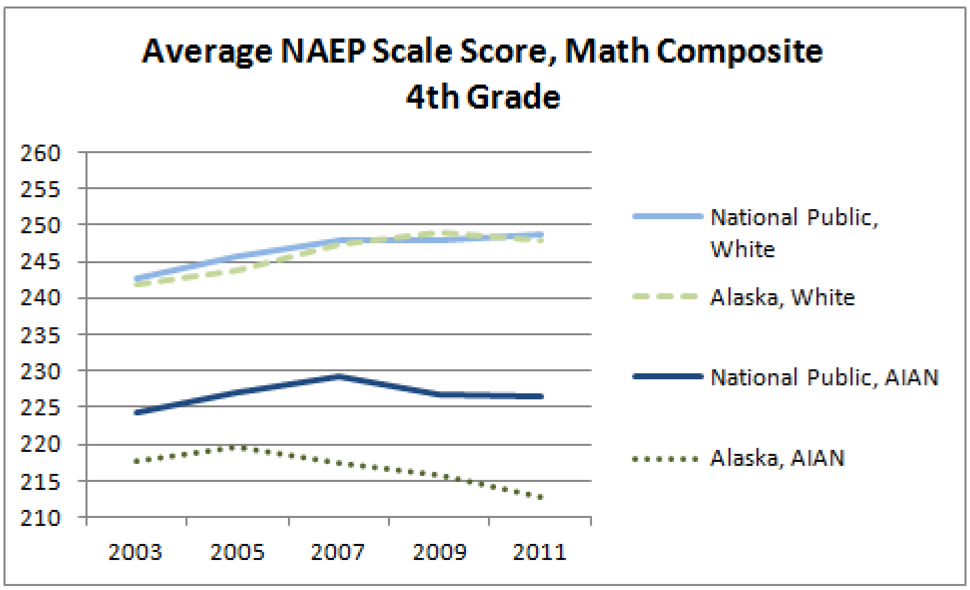

Figure 1: NAEP indicates the need to improve math scores for AN students

NAEP data in Table 1 show on average that 4th grade AN students underperformed on the different mathematics strands as compared to national proficiency standards and as compared with White Alaskan students. NAEP data and scholars (Lubienski, 2002) indicate that AN students performed the lowest on measurement and number properties and operations. Although the mathematics gap is categorically large across math strands, measurement and numbers are the two strands in which AN students underperform by the widest margin The measurement gap is particularly relevant because this project features a measurement approach to the teaching and learning of mathematics; the approach builds from Indigenous Knowledge (IK) and this measurement approach fundamentally connects different math strands (described later).

2011 NAEP Alaska Average Scale Scores			
	White	AN	Gap
Composite	248	213	-35
Algebra	250	221	-29
Data Analysis	250	211	-39
Geometry	244	218	-27
Measurement	250	209	-41
Number & Operations	246	210	-37
NAEP Data Explorer, http://nces.ed.gov/nationsreportcard/naepdata/dataset.aspx			

Table 1: NAEP indicates a gap on all math strands between AN & White Alaskans

In Alaska, those schools serving AN elementary students underperform on mathematics achievement. According to the data in Table 1, AN students performed the lowest of all groups in math proficiency (http://www.eed.state.ak.us/tls/assessment/results/2011/statewide_sba.pdf).

National, state, and district level data indicate that there is an urgent need to improve mathematics performance of AN elementary school students. In fact Alaska's SBA data of one of our partner districts, Yupiit School District, indicate a math proficiency rate of 17.5% at 3rd grade, 25.6% at 4th grade, 19.4%, at 5th grade, and less than 10% at 6th grade. Project schools such as Hoonah and the Alaska Native Cultural Charter School (ANCCC) range from near or slightly exceeding state-wide averages to the Alaska Gateway School District which averages about 10% lower to Koliganek (Southwest Region Schools) which ranged from 20 to 35% lower than state-wide averages to the Yupiit School District which averaged approximately 50% lower. See Figure 2 below—Hoonah and ANCCC reflect elementary grades, Gateway, Koliganek, and Yupiit reflect grades 3-10.

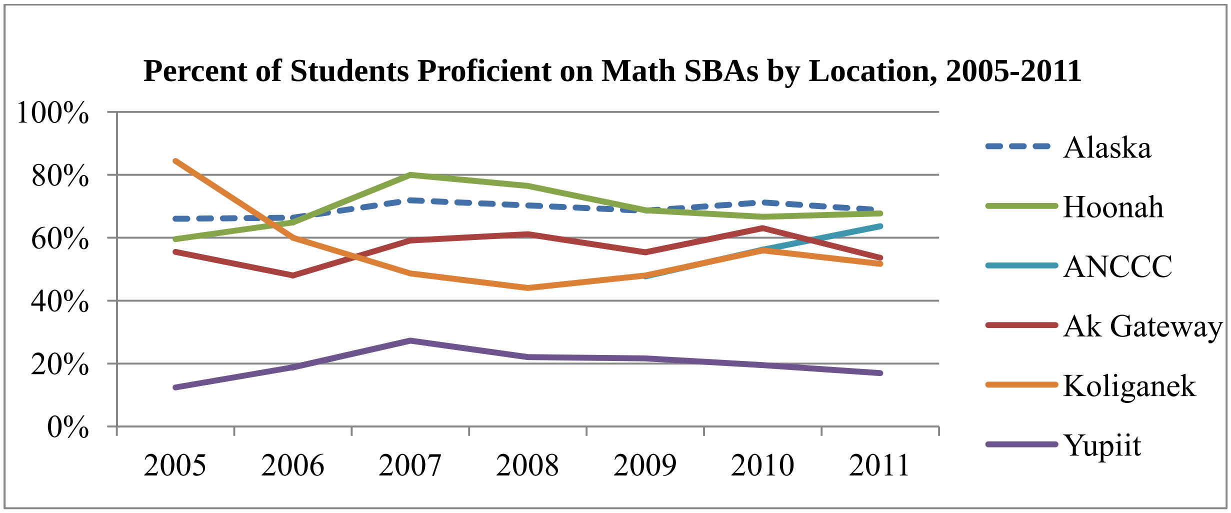

Figure 2: Alaska students' proficiency

Alaska's rural Native school districts face multiple challenges in improving student achievement. In addition to cultural factors (discussed below), AN students are disproportionately likely to be economically disadvantaged or to speak English as a second language, which bring additional challenges to teaching them effectively. Eighty-two percent of students in our partner schools and districts are eligible for free or reduced lunch programs, compared with 44% of students statewide (http://www.eed.state.ak.us/tls/cnp/NSLP.html)--specifically, 84% at the Alaska Gateway School District, 74% (Alaska Native Cultural Charter School), Hoonah at 75%, Koliganek at 88% and 91 % at the Yupiit District.

Difficulty with the English language is also a barrier to achievement for some of our partners. While Koliganek reported that none of the students who took the Spring 2011 SBAs were limited English proficient, 88 percent of Yupiit's tested students were. Among our partners, about 46% of students have limited English proficiency.

(http://www.eed.state.ak.us/tls/assessment/ayp/2011/2011DistrictAYPWorksheets.pdf)

Finally, rural school districts have high teacher turnover rates, complicating sustained school change efforts and by fueling cultural discontinuity. With the exception of the Charter School (Anchorage), our partner districts all averaged over 20% teacher turnover between 2005 and 2010. Yupiit district averaged almost 40 %. (Institute of Social and Economic Research, unpublished analysis from Alaska Department of Education data, 2011).

Need for Effective Culturally Relevant Curriculum and Professional Development

Well documented key factors associated with low performance include high poverty rates, limited English proficiency, high teacher turnover rates, and cultural discontinuity. There is a lack of culturally relevant mathematics curriculum that values Indigenous Knowledge (IK), which helps students relate school mathematics to their daily lives (Kisker, Lipka, Adams, et. al. 2012; Dalton & Tharp, 2002). Many of Alaska's rural predominantly AN districts use mathematics curricula designed for children in mainstream settings. Unfamiliar contextual examples create additional barriers for children to learn mathematics content. For example, rural Alaskan children may not relate to lots, garden area problems, transportation problems that refer trains and highways, and many other examples. Children don't identify with the texts and its material. Students do not perceive the underlying usefulness of mathematics. This approach creates obstacles to learning (Kisker, Lipka, Adams et al 2012).

In addition, mathematics is often a weak area for elementary grade teachers (Ma, 1999; Hill, H., Ball, D. et al. (2008). Similarly, interviews with project school administrators indicated that their teachers' and aides' mathematical and pedagogical knowledge needs strengthening. Interviews indicated that their districts or school desire culturally relevant curriculum and professional development—connecting school and community knowledge. These expressed needs resonate with Whitehouse Executive Order 13336 (April, 2004) calling for the inclusion of AI/AN culture and language as a way to redress the academic gap.

Similarly, there is a need to develop the materials, tools, schemas, and Professional Development (PD) processes that can bridge the wisdom of elders' practice to the teaching of school mathematics. This need is highlighted by the gap between the wisdom of elders' everyday practice, which is epitomized by their rather remarkable feats of ocean and star navigation accomplished without Western instrumentation. Elders have developed practical ways to comprehend and process complex data—angles, time, motion, and distance. Elders are able to transform irregularly shaped material into useable products by developing elegant folding and measuring procedures (Lipka, Andrew-Ihrke, & Yanez, 2011). Yet their children and grandchildren struggle with basic arithmetic operations. Thus, there is a need to bridge elders' knowledge to the teaching of school mathematics through PD and curriculum (Castagno & Brayboy, 2008; Martin, 2000).

Cultural discontinuity theory suggests that difficult concepts such as Rational Number Reasoning (Lamon, 2007) (fractions, ratios, and proportions) are made even more inaccessible when symbolic mathematics (e.g., m/n) is separated from concrete associations with the process of measuring (Davydov & Tsvetkovich, 1991). Scholars have indicated that when mathematics is taught disconnected from students' life experience in a procedural way then students' short-term memory is burdened (Hollins, 1996) because students have an inadequate mathematical conceptual framework (Kinard & Kozulin, 2000).

The National Mathematics Advisory Panel (2008) calls for students to learn topics such as measuring, geometry, and rational number reasoning (RNR) in a coherent and effective manner. Recent focus group data with teachers in most partner district have indeed indicated that the teachers do not teach mathematics in a cohesive manner (April, 2012). This is one reason why US teachers have difficulty teaching such concepts as fractions (Lamon, 2007).

B. Quality of the Project Design

The purpose of this project is to refine, develop, and implement instructional materials and professional development (PD) that will build culturally competent mathematics teachers (CCMT). The project will develop a nuanced approach to PD by responding to specific structural and cultural obstacles and turning these obstacles into opportunities for learning and engagement. The PD activities and supports will engage teachers as they learn methods to think about mathematics in a cohesive way. This proposal derives from and builds on Math in a Cultural Context's (MCC) long-term relationship with Yup'ik elders and more recently with Sami and Micronesian elders. Because of this long-term work, MCC staff has observed and understood how Elders' everyday practices embed mathematical thinking. In fact, Elders' actions on raw irregular material as they fashion it into useable products reveals an integrative and elegant way to teach math to teachers, aides, and students. Their actions reveal a measuring approach to teaching mathematics. This project will show through the development of cultural math TOOLS how elders' actions relate to fundamental mathematical foundations and connects diverse mathematics strands. Elders' practices include measuring and symmetry; these concepts underlie the teaching of aspects of RNR, geometry, measuring, and algebraic reasoning. To accomplish this, the project fundamentally connects IK and practice (content and pedagogical knowledge) with innovative developments in mathematics education. Teachers apply this knowledge to teaching mathematics in a more coherent and culturally responsive way, increasing student engagement, motivation, and learning.

Elders' construct their own tools, and teachers and students will learn math through constructing their own math TOOLS. TOOLS are used in this project in three ways: 1) for example, a tool such as a ruler is used as a measurement; 2) a measuring tool like a ruler can be thought of as generative and integrative; that is, the same measuring tool (its underlying structure) can be used to create number lines, thermometers, grouping and place value, and can be extended to time, clocks, and protractors; and 3) the tools have a cognitive component in that they support the development of students' mathematical thinking and conceptual development (Kindard & Kouzlin, 2000). More specifically, elders' everyday activity such as transforming irregular material into useable artifacts embeds powerful and generative math processes which this program will harness. For example, the elders' processes of symmetrical and proportional measuring embed the notion of equality/inequality which is a foundation for algebraic thinking. They determine equality by folding along a line of symmetry that they adjust until the two pieces are congruent (geometrical verification) (Lipka, Andrew-Ihrke, & Yanez, 2011). As they compare these areas or lengths, they are establishing notions of how much more or how much less one piece is than another (basic operations). When folding material in half in one direction and then in half in another direction and then again, they are establishing a foundation for exponential numbers and relations. Elders' processes of halving and thirding opens an alternative pathway to numbers, fractional, composite, exponential, and primes. Thus, their approach applied to teaching math can afford teachers and students with an efficient, effective, and cohesive way to teach math. Below are few examples showing how we will connect math strands as a way to develop CCMT with particular emphasis on the K-4 grade bands.

Grades K-2—Geometry – Measuring – Numbers & Operations – Algebraic Thinking

Basic Algebraic development starts from comparing nonnumeric quantities such as lengths.

Elders' comparing lengths establishes the basic foundation for algebraic thinking. Thus, hands-on experiences are tied to generalizations. For example, A + B = C; B = C – A; A = C – B; C/2 = A; C/2 = B; A < C; C > A; C ≠ B. This shows the relationship between adding and subtracting.

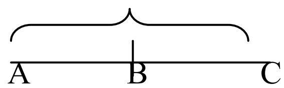

Figure 3: Schema for algebraic thinking

Measuring – Students develop their own body proportional units of measuring and apply them to a number line first nonnumerically and then numerically.

Research on students' ability with number lines supports math learning (Saxe et. al., 2007).

Numbers and Operations—applying elders' processes for halving and thirding, students learn how to partition their number line. Students construct their own fraction and measuring TOOLS.

Geometry – Students and teachers apply symmetry and proportional measuring in constructing geometrical shapes; the project begins with the square as a fundamental shape. Students learn to decompose through symmetrical folding and geometric verification as they make their own pattern set.

Grades 3-4: Geometry – Measuring – Numbers & Operations – Algebraic Thinking

Basic Algebraic – From a measuring perspective, the number line as a TOOL continues to be developed in this grade band. For example, the part/whole relationships learned previously now develop further. Elders' notion of symmetry and partitioning continues to drive these math tools.

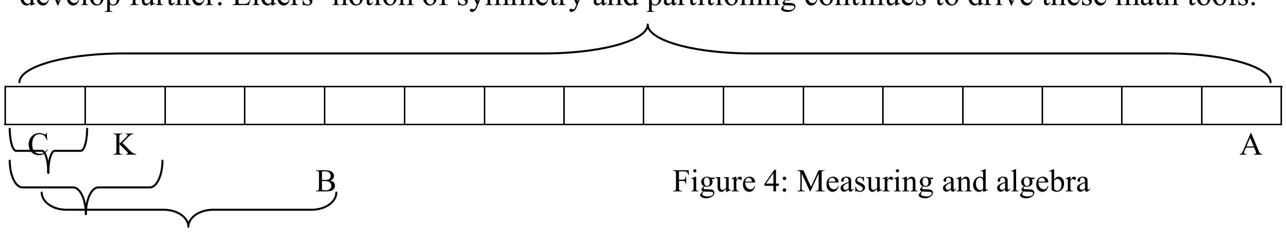

Figure 4: Measuring and algebra

A/B = 4; A/K = 8; A/C = 16A = 4B; A = 8K; A = 16C

Teachers and students learn to use the TOOL with numeric values and express these relations algebraically. Symmetrical folding and proportional measuring learned from the elders is an integral part of this TOOL and its cohesiveness.

Measuring—The relationship between measuring and the number line TOOL becomes increasingly clear. Measuring will now be applied to graphing (two number lines), partitioning into 12 equal parts will connect measuring to a length model of time and placed in a circular format to show how this TOOL can be used as a clock or a compass and later as a protractor.

Numbers and Operations—Through partitioning into equal partitions, again following elders' methods of partitioning material into halving and thirding, students create rulers, fraction strips—leading to equivalent fractions, operations, and grouping and place value.

Geometry--Following elders' ways of constructing shapes, students construct rhombi and circles. Students create area models and participate in projects related to their communities as concepts become more cohesive and connected to community practices.

Grade 5-6: Briefly, students follow the generative approach from Yup'ik elders. For example, as they further develop their fraction sets they will learn about factors, greatest common factor, the associative law, non unit fractions, mixed fractions, and apply basic operations to these through number lines and algebraically. They will use the elders' methods to explore geometrical similarity, plot it on a graph, and express it algebraically.

Projects that Integrate Culture and Math – Capstone projects integrate math and culture; for example, students will construct basic pattern sets and designs like those that adorn parkas from geometric shapes. Similarly, students will make a qaspeq for a doll, which will also connect to measuring, area, fractions, and other math areas.

These brief samples point out the underlying mathematical cohesiveness and cultural connectedness as teachers and students apply the principles of symmetry and proportional measuring across the math strands.

The project is composed of four interrelated parts: 1) the development and refinement of PD and curricular materials; 2) provision of ongoing PD to project teachers; 3) implementation of the approach by those teachers in their classrooms; and 4) ongoing assessment of all parts of the project.

The development and refinement of materials will include: a) Culturally Mediated Mathematics Tools that enable teachers and aides to teach mathematics in a cohesive manner connecting math strands and school and community. The tools will be constructed jointly by project staff with teachers and teachers with their students. The specific and coordinated TOOL set includes: number lines, fraction sets, and geometric sets—shape construction and decomposition into patterns and fractional sets; b) curricular exemplars of how to use the tools in the classroom; for example, demonstrating construction of number lines from strips and from body proportional measures, using strips and proportional body measures to build conceptual understanding of units of measure, relationships between numbers and operations, and early algebraic reasoning and how the TOOLS relate to other school math tools like graphs; c) video clips of effective implementation of the new approach, and video clips illustrating the embedded mathematics that elders use as they transform irregular materials into useable products; d) refinement of the assessment tools, including summative assessments such as unit tests and the project's Splitting/Symmetry, Multiplicative Thinking, and Understanding Fraction Instrument (SSMTUF) Lipka, Wong, Andrew-Ihrke (under review), Wong, 2010, & Wong, 2009) , and formative assessments, such as a paper folding performance tasks (Turner et. al, 2007) that project staff and teachers can use to check students' conceptual understanding; e) development and refinement of the classroom observation tool to measure teachers' growth as Culturally Competent Math Teachers (CCMT); and f) a PD and curricular guide that bring together the tools, curricular examples, and assessments with additional materials, so that the project will be sustained after the conclusion of the grant.. In some cases, teachers will lead PD for new teachers around this material after the project concludes. This is critical for sustainability, given the teacher turnover that many of our partner schools and districts experience.

Provision of on-going PD will include workshops for selected teacher leaders across project sites during a Summer Math Institute and a January workshop; all teachers will receive onsite workshops, community workshops, classroom observations, online courses, coaching and professional learning communities. Teacher leaders provide ongoing feedback on the curriculum and PD materials and processes as part of the iterative development cycle. They will act as leaders within their sites.

Classroom implementation will be part of the iterative development process, and later in the project the tools and training will be assessed for their effective use. Project teachers will initially identify opportunities to implement this approach in their classrooms for specific lessons or units. As they become more experienced with this approach, they will be able to increasingly apply it in their mathematics instruction.

Ongoing assessment: The project will use multiple indicators to measure changes in instruction, including classroom observations, teacher artifacts and self-reports, and video clips. We will measure changes in teachers' pedagogical and content knowledge through those measures. We will measure student outcomes through performance tasks, project-specific assessments, and the Alaska Mathematics SBA. We will gather baseline data in the first year of the project and will use a pre-post design for ongoing formative assessment. For summative assessment, we will conduct a small quasi-experiment comparing 12 treatment and 12 comparison group classrooms matched by demographic and test data. Students will receive project pre and posttests, and SBA data will be collected and compared.

The project has four goals, each with supporting Objectives and Measurable Outcomes:

Goal I – Development and Refinement of PD and Curricular materials

Objective 1.1: Development of mathematics tools and curricular examples.

Performance Measures: (Year 1) a. Materials emphasizing center points, lines of symmetry, and how these processes are used to construct everyday materials and are also fundamental to school math. The materials will connect Indigenous Knowledge and its embedded mathematics to formal school mathematics. b. Examples of elders' transforming irregular material into useable products (such as geometric shapes used in making a variety of projects including patterns, belts, and headdresses) and the generative mathematics embedded in these processes. This set of materials will include: square, rectangle, circle, and rhombus constructions (in DVD and paper format). c. Three culturally based math projects that connect math strands to community projects. d. Material on TOOL Construction and Use. The first tool will be the number line, from constructing and deriving a number line through symmetry and body proportional measuring to use of this TOOL to teach math cohesively (connecting algebraic reasoning, numbers/operations, and measuring), and horizontally (across multiple grade levels). We will develop approximately 10 different examples. The module will include other TOOLS developed by applying the same principles and derived from elders' knowledge. The number line will be applied to measuring (rulers), graphing, angles, clocks, and protractors (partially developed in Year 1), Geometry sets, from square or rectangle constructions, will show how to create symmetrical pattern pieces, and how to demonstrate equivalent fractions and geometrical similarity. e. Curricular examples that link the measuring and symmetry approach to algebraic thinking and basic algebraic reasoning.

Performance Measures (Year 2): refinement and piloting of Parts A, B, C, and D (above). Building on the curricular examples in E (above) we will develop, pilot and refine algebraic thinking TOOLS in YEAR 2.

Performance Measures (Year 3): all the examples and tools above will have been developed, piloted, refined, used by project teachers and refined one more time to be ready for inclusion in the final PD materials.

Objective 1.2: Development of additional PD materials

Performance Measures: By the end of year 2, we will have recorded and edited 3 video clips of effective instructional practice in K-6 classrooms, using the materials developed in year 1. By the end of year 3, we will have recorded 5 edited video clip examples of effective instructional practice in K-6 classrooms, using the materials developed in year 2.

Objective 1.3: Development of assessment tools

Performance Measures: By the end of year 1, we will have refined performance tasks around the key curricular concepts developed in year 1, and we will have completed refinements and adaptations of instruments from MCC's Fidelity instrument, Hattie (2003), and from Dalton and Tharp (2000), to produce a Culturally Competent Math Teacher (CCMT) Observation Instrument, and implemented the instrument. By the end of year 2, we will have refined one and developed a second performance tasks around the key curricular concepts developed in year 2.

Objective 1.4. Guide to developing culturally based mathematics PD and curricular examples

Performance Measures: By the end of year 3, we will have developed a Guide to developing culturally based mathematics PD and curricular examples, starting with elders' everyday knowledge and how that knowledge relates to school mathematics. It will include a brief description of the Indigenous Knowledge inspired learning trajectory developed from this approach; examples across the math strands and across the grade levels of how culturally mediated TOOLS are developed and used, and other materials to support school districts in sustaining this effort, such as the curriculum units, lessons, and tools derived from this project. These materials are intended to guide the development of CCMTs.

Goal 2: Ongoing Professional Development for Teachers

Objective 2.1. Development of site-based workshops and classroom observations

Objective 2.2. Development and implementation of an intensive summer training institute

Objective 2.3. Establishment of a project-related online learning community

Performance Measures: (Year 1) Twelve days of on-site PD workshops and classroom observations in all partner districts. (Year 1) and an intensive Summer Math Institute (SMI) for 15 project teachers and aides. (Year 1) An online learning community will have participation by 25% of project teachers. Years 2 & 3 repeats the PD cycle except without a SMI in Yr 3.

Goal 3: Classroom Implementation

Objective 3.1. Teachers will implement the project approach in their classrooms

Performance Measures: (Year 1) Approximately 15 project teachers will have implemented this approach for at least 3 weeks (10-15 lessons) using the number line TOOL, and one or more culturally based projects, and will have assessed students using project tests. During Year 1 we anticipate teachers using the TOOLS to teach measuring, geometry, and numbers. (Years 2 and 3) All project teachers will implement for a minimum of 3 weeks (10-15 lessons) with the 15 most advanced teachers (in their second project year) implementing 5 weeks (20-25 lessons), and those in their third project year using this approach during some part of all their math units. Teachers in their second and third project years will also make connections to algebraic reasoning as they implement lessons around measuring and numbers.

Objective 3.2. Teachers will become increasingly Culturally Competent Math Teachers.

Teachers' scores on the CCMT instrument will improve from baseline. In particular, we expect to detect increases in instructional conversation, increases in mathematical and cultural cohesiveness, and the more effective use of TOOLs.

Goal 4. Improve Student math achievement

Objective 4.1. Students will be able to demonstrate understanding of the principles being taught in project-based lessons

Performance Measures: Each year, 80 percent of students in project classrooms will take project pre and posttests. Each year, project classrooms will have a gain score on average of at least 15% from pretest to posttest scores.

Objective 4.2: Students will demonstrate increased math achievement **(GPRA)**

Performance Measures: In years 2 and 3, students in classrooms that implement at least 4 weeks of project-based lessons will show statistically significant increases (p=0.05) of their current year SBA Mathematics scale and Measurement subscale scores over their previous year's SBA scores. In year 3, students in the treatment (project) group of a quasi-experimental study will show higher gains (p=0.05) than students in the control group on the project-designed SSMTUF (administered at the beginning and end of the year). In year 3, students in the treatment (project) group of a quasi-experimental study will show higher gains (p=0.05) than students in the control group of their current year SBA Mathematics scale and Measurement subscale scores over their previous year's SBA scores.

C. The Quality of the Management Plan

The project's management plan is designed to ensure that the proposed program goals, objectives, products, and measurable outcomes are met in a timely manner and within budget. The plan clearly establishes the roles and responsibilities of key personnel and percentage of their effort as well as timelines and milestones. Since 1997, the MCC team has successfully administered and implemented complex projects from developing culturally based elementary school math curriculum and PD to research designs involving both qualitative and quantitative data. The project brings its long-term and ongoing relationships among its members along with the specific expertise each brings to this project as well as their long-term work with either project school districts or key administrators at each site.

The curriculum development group's expertise is distributed widely among partners. Lipka, the PI, estimates his work at 472 hours per year. He has led and organized a series of successful grant projects developing, implementing, and researching the impacts of culturally based math curricula. He will lead the curriculum and professional materials development team. He has worked with Dora Andrew-Ihrke and Evelyn Yanez (both long-term Yup'ik MCC staff and former bilingual coordinators and retired teachers) for many years. Their work is calculated at 370.5 hours per year. They have worked with elders from different communities, with teachers and school districts, mathematicians and math educators. They have also worked internationally with indigenous groups that have modeled their work on MCC's approach. Dora brings expertise in her ability to take lessons taught to her by elders and bridge that knowledge to school mathematics. Similarly, Evelyn brings deep cultural insight regarding traditional storytelling which she will connect to mathematical concepts through the spatially-oriented storyknifing (a unique Yup'ik way of combining the oral tradition with symbols, song and motion). Both will share their expertise in the curriculum and materials development component. The project will hire one full-time faculty member with Alaskan experience and expertise in PD and with a background in mathematics. The work contribution is calculated at 1640 hours per year. This individual will assist in PD and curricular exemplars development, provide onsite workshop and coaching of project teachers, observe and collect data from project sites to inform both the formative and summative evaluation. Dr. Zinger, a mathematics educator, will also have responsibilities in developing the PD approach and curricular exemplars, particularly in algebraic reasoning and the understanding of the multiplicative structure of elders' everyday activities. He will work with Lipka and Andrew-Ihrke in this process. Dr. Zinger and project staff will also offer online courses to further support teachers and the development of a Professional Learning Community across sites; his work contribution is calculated at 277 hours per year. Two math educators Dr. Greer and Dr. Mukhopadhyay (7 days each per year) will bring their expertise to the project to ensure that the underlying multiplicative and algebraic structure of the elders' everyday activities are presented in a clear and concise manner; they will assist in developing exemplars and make site visits to Hoonah where Dr. Mukhopadhyay has had prior experience. All aspects of the content, pedagogy and the PD component will be developed with input from the project two long-term Yup'ik partners, input from additional elders, and input from teachers. Finally, the management team is led by Flor Banks (work is calculated at 1040 hours per year), who has effectively managed multiple curriculum development and impact projects since 1998. She is assisted by Wendy Wood (work is calculated at 1040 hours per year). The project evaluator, Alexandra Hill, University of Alaska Anchorage, Institute of Social and Economic

Institute, will be conducting key aspects of the formative evaluation during the iterative development phases of this project (her work is calculated at 224 in Yr 1, 344 in Yr2, and 368 in Yr 3). She has conducted evaluations in multiple contexts in Alaska; her in-depth knowledge of MCC's past work and familiarity with its ongoing work make her ideally situated to conduct the formative and summative assessments.

The management plan is organized to guide the phases of the project: 1) the development and refinement of PD and curricular materials; 2) provision of ongoing PD to project teachers; 3) implementation of the approach by those teachers in their classrooms; and 4) ongoing assessment of all parts of the project. The following timeline indicates the major developments of the project and when key milestone have been achieved. Table 2 below outlines the tasks and milestones.

Project Timeline & Tasks	Year 1 2012-13			Year 2 2013-14			Year 3 2014-15		
	2012	2013	2013	2013	2014	2014	2014	2015	2015
	Fall	Spr	Sum	Fall	Spr	Sum	Fall	Spr	Sum
Dvlp & refine PD, courses									
Deliver PD		W, O	SMI	O	W, O	SMI	O	W, O	SMI
Deliver Online Courses									
Teachers Implement		Pilot							
Teacher Observations	Dvlp	Pilot	Refine						
Math Assessments	Dvlp	Pilot	Refine						
Performance Tasks	Dvlp	Pilot	Refine						
Quasi-experiment									
SBA data									
Data Analysis									

Key: W = Workshop, O – Onsite, SMI = Summer Math Institute, Shaded = ongoing

Table 2: Timeline and Tasks

We will develop and refine PD and curricular exemplars between October 2012 and January 2013 in preparation for the 1st PD workshop, which will occur during late January 2013. Concurrently, the first pilot teachers (leaders) will be identified across sites including experienced MCC teachers who will co-develop materials and assist in demonstrating how to implement the new approach. Twelve teachers will attend the first workshop. The project will focus on 3rd and 4th grade teachers and students. The project staff will continue to refine the first set of TOOLS and curricular examples immediately following the workshop. The project team will choose teachers to practice using the CCMT observation instrument. Achieving inter rater reliability with the instrument is a milestone. The first set of material will be readied for implementation beginning mid-February 2013. Baseline data will be collected during the first trip to project teacher sites. Data will include observation, teacher lesson plans, and teacher interviews to ascertain the degree to which they teach in a culturally competent and cohesive manner.

The first implementation will occur with 5 experienced MCC teachers in districts that have worked with MCC in the past. This will be followed up with implementation in the Akiak School which is part of the Yupiit School District, with at least 4 experienced AK Gateway teachers, and at least 3 experienced MCC teachers in the Charter School, and at least two teachers in Hoonah. A cycle of PD support begins in January 2013 with the first workshop, followed by onsite visits, and an online course to further support teachers' implementation. Observations of project classrooms will provide the first set of formative feedback which will be used to detect areas needing attention. Classroom visits and use of the observational instrument plus feedback from the experienced MCC teachers will guide the curricular and PD refinements during the late spring and summer of 2013. The first Summer Math Institute occurs during the summer of 2013.

Year 2 milestones and activities – During Year 2 all project teachers implement at least 10 lessons. Milestones are reached when evidence suggests that teachers are using the TOOLS and materials with fidelity, when teachers teach with mathematical cohesiveness and with connectedness to the community. The project CCMT observation instrument should detect these changes in teaching. Three video clips of effective implementation will be obtained, edited, and readied for use in the Year 2 Summer Math Institute. Milestones are reached when the Algebraic Reasoning materials are readied for implementation in Year 2 and when teachers begin to make initial connections across math strands—teaching in a manner in which the underlying mathematical structure is being taught to the students is a major milestone. We will detect this in Year 2 through CCMT, project tasks and tests. Project pre and post test scores should indicate at least a 10% gain score for project students and students' explaining connections across math strands is another milestone.

Year 3 milestones and activities – A major milestone is the organization of and the implementation of the small quasi-experimental design with 12 third and fourth grade teachers and students. Control teachers will be identified through matching SBA data and other students and teacher characteristics with Treatment school districts. We anticipate at least a 10% gain score difference between the treatment and control group and we anticipate detecting a positive difference on SBA scores. We will finalize project products—the exemplars, the Guide, clips of effective implementation. The project will work with project districts to ensure that these materials, curricular examples and Guide to curriculum and PD development in a cultural context are in place at each project site. The materials should be readied for more rigorous testing.

The achievement of milestones, goals and measurable outcomes are consistent with and demonstrate an adequate allocation of resources. (*See Budget Justification for personnel, FTE, roles and responsibilities).

D. Adequacy of Resources

(i) Reasonable cost -- The resources of the project are used reasonably in relation to the number of persons served. The cost of serving an estimated 1200 students is approximately [redacted] per student over the three years. The project will serve approximately 65 teachers and 10 aides across approximately 10 school districts. Further, the anticipated result and benefit of this project extends beyond the students, teachers, and districts directly served by this project. The Professional Development and curricular approach undertaken by this project is innovative and represents one of the few such projects in which Indigenous Knowledge is an integral component of a core academic subject—mathematics. The project has major implications for the teaching of mathematics, which has the potential to extend to other American Indian/Alaska Native communities as well as to other Indigenous communities outside of the US. For example, the PI has obtained a three year NSF grant to work with Indigenous partners across the Arctic as well as in Micronesia to determine if the symmetry/splitting and relational measuring approach documented among some AN elders also occurs in these sites. Mathematically, the approach learned from the elders has the potential to be a very efficient and cohesive way to teach mathematics.

(ii) Demonstrated commitment of the partners – During the past year, three of the partner school districts worked with the PI, Andrew-Ihrke, and Yanez to develop the approach to this project. These partners provided at their expense inservice opportunities for their teachers and aides to develop this project. This is particularly germane to the Yupiit School District where the

PI has worked with elders from this region in obtaining the background knowledge that informs the newly devised approach to teaching mathematics. Further, the partner school districts during planning meetings are ensuring that the new lessons/units, exemplars, video clips of effective teaching, and other project developments become an active part of each school district's curriculum. Districts will provide resources to further ensure the success of this project from the use of district space for meetings, to integrating key personnel from partner schools/districts to take on a leadership role. For example, one of the founding members of the Alaska Native Cultural Charter School will receive advanced training, allowing her to take on a leadership role within her school. Similarly, teacher leaders or principals within their different districts will also take on these roles.

(iii) The budget was developed to ensure that there are sufficient resources for the development of the new PD and curricular exemplars during the iterative development cycle. There is adequate support for onsite workshops, community workshops, and additional PD supports to enable teachers to become increasingly more Culturally Competent Math Teachers. There are adequate resources assigned to data collection and analysis during the iterative development cycle and resources to measure the effect of the implementation especially during the small quasi-experimental study. Thus, the personnel were chosen in response to the tasks to be undertaken, an iterative development plan is in place as well as a data collection plan.

E. Quality of the Project Evaluation

The evaluation is built around 3 key questions:

- Will the program develop and implement a high quality PD program with curriculum materials that integrate IK and support instruction that is culturally competent and cohesive across math strands?

- Will the professional development program produce changes in participating teachers' instructional practice that reflect growth as Culturally Competent Math Teachers?
- Will teachers' K6 students show discernible improvement in mathematics achievement?

The first question and the process evaluation address Goals 1 and 2. Program staff and the evaluator will track and document that the project develops the materials and implements the professional development program, and that teachers participate in PD as planned. The second question addresses project Goal 3. For the project to improve student learning, teachers must implement the new material and approach effectively. Data will come from a variety of sources. Teachers will report on their lesson implementation through brief logs that document the extent of implementation and provide formative feedback around the effectiveness of the PD and around barriers to implementation. A major project task is the further development and refinement of the Culturally Competent Mathematics Teacher (CCMT) Observation tool. We will combine and add items MCC's fidelity instrument and from Dalton & Tharp's (2000) and Hattie's (2003) validated instruments to detect teachers' growing cultural competence in teaching math. Once the tool is developed and inter-rater reliability established, project staff and evaluators will observe participating teachers twice annually and analyze the data looking for increased overall scores and for evidence of increased instructional conversation and mathematical and cultural cohesiveness.

The third key question addresses Goal 4. Again, we will use multiple measures. In classrooms of project teachers, we will sample students and track their understanding of project-related lessons through their conversations and artifacts; how they perform on performance tasks, and with scores on project-designed unit assessments. We will also use the SSMTUF to provide pre-and post- assessment of growth in student understanding of key math concepts and processes. Finally, we will look for improvements in student's overall math and measurement subscale SBA scores. For all of these outcomes, we will test for the effects of multiple years of project participation by teachers and multiple years of students' being in project classrooms, as well as the effects of different levels of teacher implementation. Given teacher turnover and student mobility, these analyses will provide guidance that the intervention is working as intended; the statistical analysis and results will be suggestive rather than definitive.

In year 3, we will conduct a quasi-experiment with two groups of 12 classrooms, matched for both teacher and student characteristics. Treatment teachers will receive the project's professional development program and materials; controls do not. Both groups will give their students the SSMTUF early and late in the school year. We will analyze students' SSMUTF and SBA gains, and look for statistically significant differences between the two groups.

The table below summarizes the data collection plan.

Data Collection table		
Project Schools	When collected	Who collects
Teacher Characteristics	Annual, fall	Submitted online
Teacher PD participation	At each PD workshop/institute	PD facilitator
Teacher PD evaluations	At each PD workshop/institute	Evaluator or PD facilitator
Teacher Logs & Artifacts	As teachers implement lessons	Teachers submit online
CCMT observations	Once in year 1, F and S of yrs 2 & 3	Project staff or evaluator
Performance Tasks	Once in year 1, F and S of yrs 2 & 3	Project staff or evaluator
Student Unit assessments	Pre- and post tests when teachers implement developed units	Teachers submit aggregate data for their class
K6 student SSMTUF	Once in year 1, F and S of years 2 & 3	Project staff or evaluator

K6 student SBA Scores	Annual, summer	Evaluator w/districts
Quasi-Study Year 3 only		
Teacher Characteristics	Fall	Submitted online
Survey of non-project PD	spring	Submitted online
Teacher PD participation	At each PD workshop/institute	PD facilitator
CCMT observations	Fall and spring	Project staff or evaluator
K12 student SSMTUF	Fall and Spring	Project staff or evaluator
K12 student SBA Scores	Summer	Evaluator w/districts

Table 3: Data management plan

The evaluation will have a strong formative component. The evaluator will work closely with the project director, as well as independently, to provide feedback on the project's design and to ensure that the data and the analytic approach can establish objective measures of project outcomes. She will make three classroom visits of two days each per year, spend two days observing/participating in PD workshops, and provide feedback on the new curriculum materials, assessments and PD activities. She will work with the curriculum development team to analyze the data and results, and discuss revisions for the next implementation cycle, and will write an annual report on the project's progress towards its goals.