Closing the Mathematics Achievement Gap of Native American Students Identified as Learning Disabled

by Judith Hankes, Stacey Skoning, Gerald Fast, Loretta Mason, John Beam, William Mickelson, and Colleen Merrill

(This is an incomplete report. Once the chapter is officially published, it will be posted on the CMAG web site in its entirety.)

Closing the Math Achievement Gap Project Intervention/Professional Development

Perhaps the most effective way to empower teachers to empower their students in mathematics is by creating opportunities for them to become actively engaged in quality professional development experiences. Half-day workshops that orient teachers to commercial curricula (typical in today’s climate of the competitive textbook market) are inadequate, since no textbook can replace a content-competent teacher who understands the learner’s culture and has mastered the complex art of teaching. The primary goal of the CMAG Project was to develop such teachers.

Recruitment of special education teachers for the CMAG Project was not difficult. Volunteers shared that they did not know how to prepare their students for the reasoning-based WKCE and that they were eager to participate in a project that offered extended professional development on teaching mathematics. Most were veteran special education teachers, averaging 17 years of teaching experience, with experience ranging from two years to twenty-nine years. All teachers were responsible for teaching mathematics to Native students identified as LD, and each came from a district with disproportionately high numbers of Native students in their special education programs.

Prior to the planning of the CMAG professional development experiences, goals for students and teachers were established (Tables 1 & 2). Student goal #1 specified that project students would demonstrate achievement at the basic level on the WKCE. The decision to identify basic achievement as a goal was made because, prior to Project Year I, most of the target students achieved at the minimal level, and many barely attempted or refused to attempt the test even when provided state-approved
accommodations, such as having the test read aloud and being given extended time.

**Table 1. CMAG Student Goals (achievement at grade level)**

| 1. Project students will achieve at the basic level on the WKCE and demonstrate problem-solving skills across all NCTM content areas (number and operations, algebra, geometry, measurement, and data analysis and probability). |
| 2. Project students will independently solve word problems. |
| 3. Project students will use numbers effectively for various purposes such as counting, measuring, estimating, and problem solving. |
| 4. Project students will communicate their reasoning and solution strategies verbally, with drawings, with models, and symbolically. |
| 5. Project students will report positive attitudes toward mathematics. |

**Table 2. CMAG Teacher Goals:**

| 1. Teachers will effectively employ Cognitively Guided Instruction (CGI) to develop mathematical reasoning and base 10 understanding. |
| 2. Teachers will demonstrate knowledge of culturally responsive teaching methods and apply these methods when teaching students identified as learning disabled. |
| 3. Teachers will demonstrate knowledge of the NCTM Content Standards and Benchmarks and will plan standards-based instruction. |
| 4. Teachers will authentically assess their students’ mathematical thinking and plan instruction based on that thinking (formative and benchmark assessments). |

The CMAG Project intervention encompassed three characteristics found in successful professional development models: (1) groups of teachers from the same school participated together; (2) workshops and reflection sessions provided high quality contact which lasted several months; and (3) teachers learned new content and pedagogy in the context of teaching (Elmore, 2002; Loucks-Horsley, et. al., 2005). A fourth important characteristic of the CMAG Project was that project personnel conducted classroom observations, and consultation sessions with project teachers several times throughout the year.

The Years I and II CMAG Project intervention activities (August 2008 to September 2009) included two 5-day workshops, two 2-day implementation reflection sessions, and at least 6 site visits per participant (lesson observations with follow-up conferences) conducted by project personnel. Face-to-face instruction during workshops and reflection sessions, totaled approximately 90 instruction hours. Additionally, project teachers were provided mathematics manipulatives and resources (i.e.,
published and unpublished mathematics lessons with activity packets, the Madison Metropolitan School District assessments [MMSD, 2008], and the Buckle Down Mathematics resources [Buckledown, 2008]). A website also was developed to provide teachers with online resources: http://www.uwosh.edu/coehs/mindsongmath/.

Though CMAG workshop sessions involved teachers in the exploration of many mathematics topics and experiences, those that teachers identified as most valuable will be described in the remaining sections of this chapter: Cognitively Guided Instruction (teaching through word problems and developing base 10 understanding), Culturally Responsive teaching, and use of the CMAG Benchmark Assessments. In addition, the Initial Findings from the CGI Project will be discussed.

Cognitively Guided Instruction

Teachers employing CGI in their instruction of formal mathematics concepts, utilize the knowledge that their students bring to the classroom (Carpenter et al, 1999). The approach complies with National Mathematics Reform Standards and Processes (NCTM, 2000) and is highly successful for developing mathematical reasoning and number sense with mainstream, as well as minority children, and average learners, as well as students with special learning needs (Behrend, 1994; Carey et al., 1993; Carpenter et al., 1999; Ghaleb, 1992; Hankes, 1996; Hankes, 1998; Peterson et al., 1991; Villasenor, 1991). This section describes the preparation of teachers to employ the CGI methods and describes the basic framework of CGI instruction.

Teachers participating in CGI workshops learned about relationships between the structure of primary level mathematics, and children's thinking of mathematics. The goal of this approach was that teachers would understand how their children learned mathematical concepts and used this knowledge when planning instruction (Carpenter et al., 1999). The content shared during CGI workshops was built on extensive research that identified regularities in children's solutions to different types of mathematical story problem situations, when children were allowed to solve problems intuitively, rather than following a teacher imposed procedure (Carpenter, 1985; Fuson, 1990 and 1992; Streefland, 1993). Of importance to the present study, was the fact that children from other cultural groups, including Native American (Apthorp et al., Hankes, 1998; Hankes 2007), Hispanic (Villasenor, 1991), African American (Carey, et al, 1995), and Lebanese (Ghaleb, 1992), demonstrated the same regularities in their solution strategies, as the dominant culture participants in the original study. This finding suggested that young children across cultures used similar cognitive processes when intuitively solving simple mathematics problems they encountered within their culture. Studies also document the success of CGI when teaching LD students (Bottge, 2001; Hankes, 1996; Behrend, 1994).
The problem solving regularities mentioned above became the basis for generating a complete taxonomy of addition, subtraction, multiplication, and division word problems, distinguished in terms of reasoning difficulty (Table 3). Teachers who understood this problem taxonomy were able to differentiate story problems, from easiest to most difficult, and used this knowledge to plan group or individual instruction. When used strategically, gradually increasing problem difficulty, the mathematical reasoning ability of students increased significantly. Table 1 provides examples of CGI one-step story problem situations with related number sentences. The location of the unknown quantity, whether at the end, middle, or beginning, influences the difficulty of the problem. The problems were coded for reasoning difficulty: easiest with a shamrock ♦, slightly more difficult with a shamrock and diamond ♦♦, more difficult with a diamond ♦, and most difficult with a heart ♦. The story problems in Table 3 are based on the story How the Bear Lost His Tail. This story is included in the section titled, A CGI Culture-based Lesson.

Table 3. CGI Story Problem Situations

<table>
<thead>
<tr>
<th>JOINING PROBLEMS</th>
<th>SEPARATING PROBLEMS</th>
<th>PART-PART-WHOLE PROBLEMS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Join: Result Unknown</strong> (JRU) ♦</td>
<td><strong>Separate: Result Unknown</strong> (SRU) ♦</td>
<td><strong>Part-Part-Whole: Whole Unknown</strong> (PPW:WU) ♦</td>
</tr>
<tr>
<td>Bear had 5 fish. Otter gave him 8 more fish. How many fish does Otter have now?</td>
<td>Otter had 13 fish. He gave 5 fish to Bear. How many fish does Otter have left?</td>
<td>Otter has 5 big fish and 8 small fish. How many fish does Otter have altogether?</td>
</tr>
<tr>
<td>5 + 8 = □</td>
<td>13 - □ = 5</td>
<td>5 + □ = 8</td>
</tr>
<tr>
<td><strong>Join: Change Unknown</strong> (JCU) ♥</td>
<td><strong>Separate: Change Unknown</strong> (SCU) ♥</td>
<td><strong>Part-Part-Whole: Part Unknown</strong> (PPW:PU) ♥</td>
</tr>
<tr>
<td>Bear had 5 fish. Otter gave him some more. Then Bear had 13 fish. How many fish did Bear give Otter?</td>
<td>Otter had 13 fish. He gave some to Bear. Now he has 5 fish left. How many fish did Otter give Bear?</td>
<td>Otter has 13 fish. Five are big and the rest are small. How many small fish does Otter have?</td>
</tr>
<tr>
<td>5 + □ = 13</td>
<td>13 - □ = 5 or □ + 5 = 13</td>
<td>13 - □ = 5</td>
</tr>
<tr>
<td><strong>Join: Start Unknown</strong> (JSU) ♠</td>
<td><strong>Separate:Start Unknown</strong> (SSU) ♠</td>
<td></td>
</tr>
<tr>
<td>Bear had some fish. Otter gave him 8 more. Then he had 13 fish. How many fish did Bear have any?</td>
<td>Otter had some fish. He gave 5 to Bear. Now he has 8 fish left. How many fish did Otter have before he gave any to Bear?</td>
<td></td>
</tr>
<tr>
<td>□ + 8 = 13</td>
<td>□ - 5 = 8</td>
<td></td>
</tr>
</tbody>
</table>
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COMPARE PROBLEMS

<table>
<thead>
<tr>
<th>Compare: Difference Unknown (CDU)</th>
<th>Compare: Quantity Unknown (CQU)</th>
<th>Compare Referent Unknown (CRU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Otter has 8 fish. Bear has 5 fish. How many more fish does Otter have than Bear?</td>
<td>Bear has 5 fish. Otter has 3 more fish than Bear. How many fish does Bear Otter have?</td>
<td>Bear has 5 fish. He has 3 fewer fish than Otter. How many fish does Otter have?</td>
</tr>
<tr>
<td>8 - 5 = □ or 5 + □ = 8</td>
<td>5 + 3 = □</td>
<td>□ - 3 = 5 or 5 + 3 = □</td>
</tr>
<tr>
<td>8 + 3 = □</td>
<td>5 + 3 = □</td>
<td></td>
</tr>
</tbody>
</table>

MULTIPLICATION & DIVISION PROBLEMS

<table>
<thead>
<tr>
<th>Multiplication (M)</th>
<th>Measurement Division (MD)</th>
<th>Partitive Division (PD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Otter has 4 piles of fish. There are 3 fish in each pile. How many fish does Otter have?</td>
<td>Otter had 12 fish. He gave them to some crows. He gave each crow 3 fish. How many crows were given fish?</td>
<td>Otter has 12 fish. He wants to give them to 3 crows. If he gives the same number of fish to each crow, how many fish will each crow get?</td>
</tr>
<tr>
<td>4 x 3 = □</td>
<td>12 ÷ 3 = □</td>
<td>12 ÷ 3 = □</td>
</tr>
</tbody>
</table>

Problem chart based on Cognitively Guided Instruction Problem Types (Carpenter et al., 1999)

Extensive research documented that the taxonomy of CGI story problems (Table 3), provided a framework for identifying the intuitive cognitive processes that children use when solving word problems. After conducting interviews with hundreds of primary-age children, during which the children were encouraged to intuitively solve word problems without assistance, researchers found that when children first begin to solve problems, they concretely represent the number relationship within the problem. They also found that, over time, concrete strategies were abstracted to counting strategies and then to derived fact strategies. These reasoning strategies were categorized into three developmental stages: direct modeling, counting on/back, and derived facts (Carpenter et al, 1999). An explanation and example of the type of solution that a child would use at each stage are given in Table 4.

Table 4. Children’s Solution Strategies for Solving Word Problems

<table>
<thead>
<tr>
<th>Word Problem (Join Result Unknown)</th>
<th>Direct Modeling</th>
<th>Counting On/Back Strategies</th>
<th>Derived Facts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grace had 4 cookies. Bryce gave Grace 8 more cookies. How many cookies does Grace have now?</td>
<td>The child uses concrete objects or tally marks to...</td>
<td>The child generally begins by counting...</td>
<td>The student uses known facts and...</td>
</tr>
</tbody>
</table>
represent each whole number in the problem type. The child uses the objects to “act out” the problem when solving.

| The child counts out 4 cubes and puts them in a pile. Then the child counts out 8 cubes and puts them in a pile. Finally, the child pushes the two piles together and counts all cubes to reach the answer. | The child holds 4 in his/her mind and counts on the additional quantity of 8 saying, “Five, six, seven, eight, nine, ten, eleven, twelve.” | The child splits the 4 into 2 + 2, adds one of the 2s to the 8 to make 10 and then adds the other 2 to make 12. |

| Knowledge of CGI word problem situations (Table 3) and stages of children’s mathematical thinking (Table 4), provides a coherent analysis of the structure of single-step word problems, as well as the developmental strategies that children use when acquiring the ability to solve such problems. Working with the CGI problem-solving taxonomy had a cumulative effect: experience solving single-step problems built toward the ability to solve multi-step problems; place value concepts and multi-digit operations became natural extensions of the processes children used when frequently solving problems; when solving partitive division problems, children's understanding of fraction concepts also emerged (Emson, 1995; Streefland, 1993); and posing frequent problems to students and attending to their solutions enabled teachers to explore other mathematics content (telling time, geometry, measurement) through the eyes of their students (Carpenter et al., 1999; Hankes, 1998). Developing mastery of CGI (teaching mathematics content through problem solving, basing instruction on student thinking, and developing number sense in the context of problem situations) takes time. However, providing frequent problem-solving experiences develops competence and confidence, within both students and the teachers. Students become independent problem solvers, and teachers learn to base instruction on their students’ reasoning abilities. Understanding their students’ thinking was especially important for teachers in special education, and in inclusive general education classrooms, since possessing the taxonomical knowledge of CGI allowed the teacher to differentiate instruction. |
During the CGI workshop, emphasis also was placed on developing student understanding of base ten, in the domains of addition and subtraction, multiplication and division, multi-digit operations, algebra, geometry, and fractions. Typically, in regular education and special education classrooms, students had not been expected to do story problems, until they mastered their number facts and routine arithmetic procedures. However, this was not the case in the CGI classroom. In contrast, students developed number sense by solving story problems, gradually progressing from manipulating with counters, to deriving quantities using non-routine procedures.

One CMAG Project expectation was that teachers would provide whole class or small group story problem instruction daily. Teachers also were asked to organize a classroom Word Problem Center, placing story problems in coded folders (based on the difficulty taxonomy coded in Table 3: shamrock, shamrock/diamond, diamond, heart, and multi-step problems). Numbers were not included in some problems to allow students the opportunity to develop more independence by choosing their own numbers. Students were to be given time each day to self-select and independently solve, at least one problem from the Word Problem Center, pasting the self-selected problem in a Math Journal (a spiral notebook) and drawing or writing the solution beneath the problem.

Culturally Responsive Teaching
(This is an incomplete section. Once the chapter is published, the complete chapter will be added to the CMAG website.)

Along with CGI, the principal investigator focused on culturally responsive teaching during the CMAG Project workshops, making clear to the teachers how intrinsically linked the two were as CGI teaching methods, aligned to a great extent with traditional Native American teaching methods. This section describes the alignment and presents an example of a CGI culture-based lesson.

A CGI Culture-based Lesson

The following story with related word problems is as an example of how mathematics can be integrated into a culture lesson. The story, written by a team of students studying CGI during a summer pre-college program, is available with other stories on the CMAG website at http://www.uwosh.edu/coehs/mindsongmath/ethnomath/legend/legend1.htm.

How Bear Lost His Tail

A legend told by Jerry Smith, an Ojibwe Elder, to Marian, Doreen, and Leonard Belille

Long, long ago there were only creatures on the earth. There were birds, bears, deer, mice, everything but people. In this long time ago, all the animals spoke the same language. And just like some people nowadays,
they played tricks on one another and made each other laugh. They also helped each other. So it was with all the animals.

One day in the winter, when the lakes had frozen, but before the winter sleep, Bear was walking along the lakeshore. As he was walking, he came upon Otter sitting near a hole on the ice with a pile of fish. “You’ve got a mighty big pile of fish there,” Bear said. “How did you get them fish?” Instead of telling how he dove down into the water and caught the fish, Otter decided to trick Bear. You see, back then Bear had a very long bushy tail. He was very proud of his tail and all the animals knew it.

“The way I catch my fish is by putting my tail in this ice hole,” Otter explained. “I wiggle it around once in a while so the fish see it. When a fish bites onto my tail, I quickly pull it up and out of the water.”

“That sure is an easy way to catch fish,” Bear said. “Do you mind if I use your fishing hole?” Otter, laughing behind Bear’s back, said, “I have enough fish. Use my fishing hole as long as you like.” Then Otter picked up his fish and walked away. Bear carefully poked his tail into the ice hole and waited. He waited and waited. Once in a while he’d wiggle his tail so the fish could see it. Bear waited until the sun began to set, but not one fish even nibbled at his tail. At last, he decided to go home, but when he tried to stand up, his tail had frozen into the ice! He couldn’t move! He pulled and pulled at his tail, but it was stuck tight. Finally, he pulled with all of his strength and ripped off half his tail!

Now you know why the Bear has a short tail, and remember, don’t always believe what people tell you.

Instructions: Choose numbers that you want to work with and solve the problems. Show how you solved them using a drawing or with words in your Math Journal.

1. Otter went fishing. He caught ____ big fish and ____ little fish. How many fish did Otter catch? ♦ (PPW:WU)
2. Otter caught ____ fish. He gave ____ fish to a friend. Now how many fish does Otter have? ♦ (SRU)
3. Otter has ____ fish. Bear has ____ fish. How many more fish does Otter have than Bear? ♦♥ (CDU)
4. ____ fish were swimming in the pond. Some swam away. Then there were ____ fish swimming. How many fish swam away? ♥ (SCU) 5. Otter caught 12 fish. He put them into 3 piles. How many fish did he put in each pile? ♦♥ (PD)

Teaching suggestions: After reading the story aloud, project or write the problems on the chalk/white board, or copy and give them to the student/s. Read all problems aloud (re-read as needed), and have students solve independently or in small groups. After solving the problems, have the student/s explain their solution strategies by demonstrating and using words.

Initial Findings from the CMAG Project
Following completion of Project Years I and II, analysis of coded lesson observation data, teacher interview transcriptions and email surveys, teacher content knowledge assessments, and analysis of target student attitudes and achievement data was completed. This section describes findings of this analysis. Similar data collection and analysis will continue throughout Project Year III.

Results from an Email Survey

An email survey sent to project teachers in September 2009, posed two questions:

Since beginning the CMAG Project, have you observed noticeable improvements in your students' mathematics performance and achievement? If so, what are the three main reasons for this improvement? Please begin with the one that you feel had the greatest influence.

Response analysis revealed that all of the teachers believed their students’ mathematics achievement had improved.

The 10 commonly shared reasons were:
1. Students were solving and writing their own word problems, and this improved comprehension;
2. Students were solving problems in different ways, trying new ways to solve;
3. Students were thinking about what the problem was asking, not just adding numbers;
4. Instruction was not textbook and worksheet driven;
5. Students could use manipulatives when solving problems;
6. The chalkboard and whiteboards were used more often;
7. The teacher asked more “Why?” questions;
8. Students worked in groups, and more students were teaching students;
9. Students were thinking through math more; and
10. Students were writing number sentences and understanding what they meant.

One teacher responded, “The largest improvements have come in the area of self-confidence. The kids are not afraid to share or make mistakes. They can also solve more problems, because they can do it any way they know how to, instead of relying on the one procedure they had been taught in the past. More specifically:
1. They have been given permission to use their own thinking;
2. The students are learning from each other; and
3. They actually understand what they are doing and can explain it!”

These anecdotal remarks provided evidence suggesting the effectiveness of
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using CGI instructions with students. The next section documents some of the emerging statistical evidence related to the Project.

CGI Assessment Findings

During the first introductory workshop in Fall 2008, teachers were trained to pre and post-assess target students, grades K – 10, with three informal ability-adaptable protocols: 1) the CGI Word Problem Interview; 2) the Base 10 Interview; and 3) the Student Attitude Assessment. Due to confusion over expectations and procedures, many teachers did not properly administer these assessments. Consequently, there were fewer complete data sets than anticipated.

Forty-three target students, grades 3 – 8 were assessed Fall 2008 and again spring 2009, with the CGI Word Problem Interview (14 test items). This assessment could be adjusted by the teacher to meet the instructional level of the student. For instance, depending on a student’s number sense, the teacher could choose to use single digit numbers in the word problem, or double- and triple-digit numbers. The mean score in the fall was 6.58, with a standard deviation of 3.92. In the spring, the mean score increased to 9.23, with a standard deviation of 3.70. A paired t-test indicated a statistically significant improvement in problem solving performance from the fall to the spring of the same academic year (t= 4.24, α < .01).

Thirty-six target students (grades 3 through 8) were assessed in Fall 2008, and again Spring 2009, with the Base Ten Assessment (10 test items). This assessed student understanding of quantity and place value. The mean score in the fall was 3.51, with a standard deviation of 2.42. In the spring, the mean score increased to 5.76, with a standard deviation of 2.76. A paired t-test indicated a significant improvement in Base Ten understanding from the fall to the Spring (t= 6.10, α < .01).

Thirty target students (grades 3 through 8) were assessed Fall 2008, and again Spring 2009, with a 50-point Student Attitude Assessment. On this assessment, the student’s mean score in the Fall was 30.7, with a standard deviation of 10.3. In the spring, the mean score increased to 34.7, with a standard deviation of 8.50. A paired t-test indicated a significant improvement in attitude toward mathematics from the fall to the Spring, at the .05 level of significance (t= 2.60, α = .014).

Reports from Teachers on Student Preparation for the State Test

Analysis of pre and post CMAG Project mathematics scores on the state test, the Wisconsin Knowledge and Concept Exam (WKCE), documented significant mathematics achievement gains. Project teachers attributed this improvement not only to their implementation of Cognitively Guided Instruction but also because, as participants in the CMAG Project, they had come to understand how test items aligned with state mathematics content standards, and they learned how to prepare their students for solving the
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One special education teacher explained: Before working with this project, I didn’t know anything about the state math standards and how the test related to them. To me, the math section of the WKCE seemed to be a bunch of disjointed test questions. I objected to being required to give the test to my students because, well, I didn’t think they could do it.

The NCLB accountability-driven mandate to include students with LD in state testing created a unique dilemma for special education teachers. The basis for this dilemma was that the assessment of mathematics knowledge changed significantly, following the 1989 National Council of Teachers of Mathematics (NCTM) reform, a constructivist-based reform (Brooks & Brooks, 1999) that called for mathematics instruction in the United States to focus on reasoning and problem solving, rather than basic skills (NCTM, 1994). In spite of three decades of opposition from proponents of the “Back to Basics” movement (Delvin, 1998), the NCTM “thinking math” reform became established in regular education classrooms (NCTM, 2000). However, this reform did not impact special education, until the NCLB mandate (Brownell, Hirsch, and Seo, 2004; Sherman, 2008).

Not unlike special education teachers across the nation, the CMAG Project teachers were frustrated by the NCLB mandate, that required students identified as learning disabled to be included in state testing. The primary cause for their concern was the fact that their pre-service preparation, most predating the NCTM reform, had prepared them to focus on basic skill development, and they realized that this form of instruction did not prepare their students for the state reasoning–based assessment.

Some teachers attempted to use sample test items that were posted on-line by the Wisconsin Department of Education but found these to be developmentally inappropriate. During a discussion regarding the use of released items, several teachers commented that they believed prepping with them was counter-productive. One special education teacher said, “Working with them [released items] created more anxiety, and they [her students] gave up before they started. They didn’t even try.” Another teacher wrote, “Because of failing over and over again, my students give up when they are expected to do something that they find difficult. Instead of trying them [released items], they just give up. So, I end up showing them how to solve, but it doesn’t help.” What teachers described was the phenomenon of learned-helplessness, the tendency to give up when confronted with a task considered too challenging (Abrahamson & Seligman, 1978; Roth, 1980; Young & Allin, 1986).

When preparing students who exhibit learned helplessness for a problem-based test like the WKCE, it is important to make the experience safe, not insultingly simple and not overwhelmingly difficult. To achieve this balance, a leveled assessment for grades K – 7th was developed, the CMAG Benchmark Assessment. This multi-grade assessment included WKCE aligned assessments developed by the Madison Metropolitan School District, assessments for grades K - 2nd (MMSD, 2008) and by the Buckle
Down Publishing Company, assessments for grades 3 - 7th (Buckledown, 2008). At the beginning of Project Year I, teachers were asked to use these benchmark assessments strategically: to begin with one that they felt was at the student’s confidence level and to progress on toward the student’s instructional level. If a student achieved 75% on one level, the student was to be assessed with the next level.

The CMAG Benchmark Assessments were coded with grade-associated symbols, rather than identified by grade level numbers. Because of the wide range of students in inclusive classrooms or pullout special education classrooms, this manner of coding was especially important because it allowed teachers to begin assessing at each student’s comfort level, and to progress to the instruction level without using a test the student could identify as indicating that he/she was below grade level.

Additionally, teachers were instructed to have the student/s solve no more than five items at a time, and then to discuss these items before progressing to the next five items. When discussing test items with the students, teachers were advised to probe for understanding and to guide students with questions, rather than show how to solve the problem. In this way, teachers developed the ability to teach through questioning, the teaching approach used during Cognitively Guided Instruction, and recommended by the National Council of Teachers of Mathematics (NCTM, 2000).

To determine views about using the CMAG Benchmark Assessments, teachers were asked, “What impact did the CMAG Assessments have on your teaching and student learning?” They reported that:

1. Students were more willing to attempt WKCE test items;
2. They became knowledgeable about what mathematics content they needed to teach to prepare their students for the WKCE. One high school teacher wrote, “Now I know what to teach, and I can explain to parents that we are covering number operations, algebra, measurement and data and stuff like that. I didn’t know what to say before;”
3. Processing the CMAG Benchmark Assessments with their students changed how they taught; they began to ask questions rather than showing how to solve;
4. They were surprised that their students were able to reason and problem solve and were impressed with their students’ unique solution strategies;
5. *Their students enjoyed math discussions; and
6. They were surprised that their students did not know basic skills or possess base 10 understanding – this lack of basic skills knowledge was especially surprising since basic skills had been the focus of instruction in previous years.

These comments suggest that working with the CMAG Benchmark
Assessments accomplished far more than preparing students to write the state test. Of special importance, is the fact that teachers reported that their students enjoyed the mathematics discussions that the CMAG assessments stimulated.

Target student achievement gains on the state test also suggested that preparation with the CMAG assessments contributed to student learning. The mathematics results of 56 target students in grades four to eight who completed the standardized state test, the Wisconsin Knowledge and Concept Exam (WKCE), in both 2008 and 2009 were analyzed and compared. Students on this test are rated as having achieved minimal, basic, proficient, or advanced competency. These competencies are also scored numerically as 1, 2, 3, or 4 respectively. The 2008 test resulted in a mean score of 1.68 with a .88 standard deviation. The 2009 test resulted in a mean score of 2.02 with a .96 standard deviation. A t-test comparing these results indicated a significant improvement ($\alpha = .001$) in the 2009 test results over the 2008 results. The average increase in scores of the 2009 results compared to the 2008 results was .34 with 18 students advancing in their rated competency category, and of the 56 students, 18 rated proficient or advanced.

Furthermore, the WKCE mathematics results of 26 students in grades four to eight who completed this test in both 2007 and 2009 were analyzed and compared. As described above, students were rated as having achieved minimal, basic, proficient, or advanced competency scored as 1, 2, 3, or 4 respectively. The 2007 test resulted in a mean score of 1.15 with a .46 standard deviation, and the 2009 test resulted in a mean score of 1.62 with a .85 standard deviation. A t-test comparing these results indicated a significant improvement ($\alpha = .001$) in the 2009 test results over the 2007 results. The average increase in scores of the 2009 results compared to the 2008 results was .46 with 10 of the 26 students advancing in their rated competency category.

It should be noted that the minimum raw score for a particular competency category increases as the grade level increases. Consequently, even though a student remains at a certain competency level, it does not mean that the student has not obtained a higher raw score or has not learned anything. For a student to advance in competency level indicates that that the student is doing better with the more advanced content in the higher grade than they did with the more basic content in the lower grade. This is indeed a noteworthy achievement. The fact that the achievement scores of minority students typically decline significantly in middle and high school (Boyer, 2000; Hannah-Jones, 2009; Toppo, 2009), suggests that the CMAG Project positively influenced the achievement of the target students. This effect will be further explored as the study progresses.

**Target Students’ Ability to self-select and Solve Word Problems**
At the end of Year II, target students’ Math Journals were collected and 58 journals were randomly selected for analysis to determine whether 1) the level of difficulty of the problems students were self-selecting at the beginning of the year compared to the level of difficulty of the problems they were selecting at the end of the year; and 2) the success students were experiencing with the self-selected problems at the beginning of the year compared to the success they were experiencing at the end of the year.

The difficulty level of each problem attempted was rated as 1 (easiest), 2 (moderate), and 3 (challenging). Two problems were selected at random from those attempted at the beginning of the year. They were rated according to the preceding scale. The mean of these ratings was then computed and used to represent the student’s problem difficulty level attempted. The same procedure was used to determine the rating for the students’ problem difficulty level attempted at the end of the year.

The mean attempted problem difficulty level at the beginning of the year for the 58 students selected was 1.74 with a standard deviation of 0.69. The mean attempted problem difficulty level at the end of the year was 2.42 with a standard deviation of 0.58. A paired sample two-tailed t-test showed that the attempted problem difficulty level at the end of the year was significantly greater than the attempted problem difficulty level at the beginning of the year with $\alpha < .001$.

The success level in solving each of these problems attempted and randomly selected for analysis, as described above, was also rated. A rating of 0 to 3 was utilized with 0 indicating no success to 3 indicating complete success. The mean of these ratings was then computed and used to represent the student’s level of problem solving success at the beginning of the year and at the end of the year.

The mean attempted problem success level at the beginning of the year for the 58 students selected was 1.49 with a standard deviation of 0.84. The mean attempted problem success level at the end of the year was 2.04 with a standard deviation of 0.76. A paired sample two-tailed t-test showed that the attempted problem success level at the end of the year was significantly greater that the attempted problem success level at the beginning of the year with $\alpha < .001$.

**Conclusion**

The fact that disproportional numbers of Native students identified as learning disabled fail to achieve academic success is a concern for Wisconsin tribes (Fiedler et al, 2007; Leary, 2007). However, this problem is not unique to Wisconsin, it is a problem facing tribes across the nation (Deloria & Wildcat, 2001; Demmert, 2001; Soldier, 2005). This is a problem that impacts the self-sufficiency of tribal nations, since success in today’s society, on and off the reservation, requires mathematical
competence. However, empowering teachers to empower students is more than an economic driven goal. When failure results in underdeveloped potential, learned helplessness, and discouragement, empowering teachers to empower students with mathematical competence becomes a sacred mission. Efforts of the CMAG Project to embrace this mission have proven to be positive. During the writing of this chapter, Year III of the study was being conducted, and project teachers continued to report positive student achievement, as well as positive student attitudes. The following teacher comments regarding student attitudes toward math have been and continue to be typical:

1. They are coming up with a solution that makes sense to them, and this makes them feel good.
2. There is not somebody saying, “That is not right. Do it this way”. So they are feeling better about themselves.
3. It’s not a matter of them seeing that they get F’s on their paper or their work is marked wrong. They just explore, and they have fun doing it.
4. They love story problems and graphing.
5. I see the kids enjoying math more, so much more. They love it.

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