An Analysis of the Performance Gap Between American Indian and Anglo Students in the New York State Fourth and Eighth Grade Mathematics Assessments

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This study explores differences in mathematics assessment results between American Indian students in Western New York and their Anglo peers. The sample consisted of 2,256 fourth grade students (Native=323 Anglo=1933) and 2,475 eighth grade students (Native=353 Anglo=2122). Scores from New York State's Fourth and Eighth Grade Math Assessments were examined to identify areas of mathematics that contribute to the gap in performance. Analysis of scores indicated that 58% of Native students and 75% of Anglo students were mathematically proficient on the Grade Four assessment. By eighth grade, 20% of Native students and 45% of Anglo students were mathematically proficient. In particular, 34% of Native students and 14% of Anglo students scored at the lowest level on the Grade eight assessment and have little chance of passing the high school exam required for graduation. The greatest disparities between the two groups were in mathematical reasoning and uncertainty. Professional development for area math teachers and after school enrichment activities is recommended.

Introduction

The *Principles and Standards for School Mathematics* (National Council of Teachers of Mathematics [NCTM], 2000) acknowledges well documented examples demonstrating that all children "can learn mathematics when they have access to high-quality instructional programs that support their learning" (p. 13). Furthermore, they recommend that teachers maintain "high expectations that all children should learn with understanding, including children of minorities or from poor communities" (p. 371). This is consistent with new legislation from the federal government in the form of the No Child Left Behind Act of 2001, the

purpose of which is "to ensure that all children have a fair, equal, and significant opportunity to obtain a high-quality education and reach, at a minimum, proficiency on challenging state academic achievement standards and state academic assessments" in the core academic areas of reading, mathematics, and science (No Child Left Behind Act of 2001). Thus we have a goal for mathematical proficiency for all learners. The definition of proficiency, although left to individual states, generally implies a level of performance that is reflective of the standards themselves.

When one speaks of reaching this level of proficiency for all learners, there is considerable concern for those children that NCTM (2000) calls "children of minorities or from poor communities." In particular, we note the fairly well documented existence of a performance gap in mathematics achievement between American Indian/Alaska Native students and their Anglo peers (Scott, 1983; Trent & Gilman, 1985). National Assessment of Educational Progress (NAEP) results for the year 2000 report that the average score of fourth grade American Indians/Alaska Natives was 20 points below the average score of 236 by their Anglo peers, (although the average score of both groups is below a proficient level of 249). According to the NAEP data, a "gap" has existed in average scores for 1996, 1992, and 1990. Similar "gaps" in achievement exist at eighth grade. While not necessarily significant, these gaps do exist and may have contributed to Executive Order 13096 signed by President Bill Clinton in 1998 calling for, among other issues, the improvement of mathematics of American Indians/Alaska Natives and to "establish baseline data on academic achievement and retention of American Indians and Alaska Native students in order to monitor progress" (Strang & von Glatz, 2001, p. 45).

In Western New York there are four schools that contract with the New York State Department of Education for tuition assistance and supplemental funding for American Indian students in the region. In part as a response to the No Child Left Behind legislation that aims for proficiency in mathematics for all children by the year 2014, New York State requires all children to pass a high school examination in mathematics in order to graduate from high school. Given the identification of achievement gaps between American Indian/Alaska Native and Anglo children, the call to monitor progress of achievement of American Indian/Alaska Native learners, and the demand for proficiency, it is important to examine performance measures to determine whether, and to what extent, achievement gaps in mathematics exist and in what specific topic domains.

New York State currently administers mathematics performance assessments at fourth and eighth grade. These assessments are aligned with national standards in mathematics and are intended to serve at least two principle purposes. First, they provide school administrators with an opportunity to identify poorly performing schools across the state. Once identified, schools can then be required to show improvement in their achievement of the standards. Second, these assessments are used to identify students in need of academic intervention

services (AIS). One purpose of these services is to help prepare students to pass the required high school mathematics examination.

Both the fourth grade and eighth grade assessments focus on seven competency areas that mirror the standards established by the National Council of Teachers of Mathematics. These include patterns/functions, uncertainty, measurement, modeling/representation, operations, number/numeration, and mathematical reasoning. These assessments are given to all New York State fourth and eighth graders and consist of multiple choice questions, and constructed response items.

Performance results on these items, as determined by electronic scoring of the multiple choice items and use of detailed rubrics for the constructed response items, are combined to produce an individual score, which in turn is translated into a level score ranging from 1-4. New York State has defined proficiency as achieving a level 3 or 4 on the Grade 4 and Grade 8 mathematics assessments (Kadamus, 2003).

Studies by Degenfelder, Howard, and Boynton (2003) and Timbs (2002) indicated that the performance levels on the eighth grade mathematics assessment were solid predictors of future scores on New York State's required high school examination in mathematics producing correlations in excess of 0.75. In addition, students scoring at the lowest performance levels (level 1 and level 2) had only a 22% chance of passing the required high school mathematics examination and were targeted for Academic Intervention Services. Because of this the questions of whether American Indian children are meeting this defined level of proficiency, and whether they can fulfill the requirements for high school graduation, become important.

Methodology

Subjects

For the four schools identified that contract with New York State Department of Education for the American Indian students, we obtained assessment scores of all children (both Anglo and American Indian) on the fourth and eighth grade mathematics assessments through the cooperation of the Erie 2 Chautauqua Cattaraugus Board of Cooperative Educational Services (BOCES) for the years 1999-2002. During this four-year period assessment scores from 323 American Indian and 1933 Anglo fourth grade students and 353 American Indian and 2122 Anglo eighth grade students were recorded. It should be noted that demographic data available indicated that 64% of Native students belonged to low-income families compared to 30% of Anglo students based on reduced or free lunch data. As the data we received was not disaggregated on this dimension, we cannot compare performance along this dimension.

Design and Procedures

Analysis of the data involved a comparison of the raw scores of the children's performance on the assessments. The proficiency levels identified by New York

State served to frame the classification of these scores and were further classified as low, middle, or high within each level. We did this to determine the proportion of students for whom relatively small changes in their academic program could result in their advancing to a higher proficiency level.

Further analyses used the scores provided, to examine both the differences among American Indian and Anglo students' performance overall, and within each of the seven competency areas. Because the way New York State calculates level scores results in no established indicator for performance proficiency within the competency areas, we used a score of 71% or higher as a benchmark to indicate proficiency. To test whether these differences are substantial, we calculated 99% confidence intervals to provide estimates of the actual difference in performance between American Indian and Anglo children.

Results and Discussion

Fourth Grade

Level Comparison Proportions: Regarding a comparison of the raw scores on the fourth grade assessments, Figure 1 displays the distribution of scores by proficiency level for fourth grade. Approximately 15% of fourth grade American Indian students performed at a high level 2. Consequently, we conjecture that a relatively minor improvement to their academic program should push them into the third level, which indicates proficiency in mathematics. A startling observation is that at the fourth grade level, only 58% of American Indian students are proficient (level 3 or 4) as compared to 75% of their Anglo counterparts, a difference of approximately 17%.

Level Comparisons Differences: Table 1 shows the difference in performance levels between American Indian and Anglo students in terms of the average raw score on the assessments. The measured difference in average score

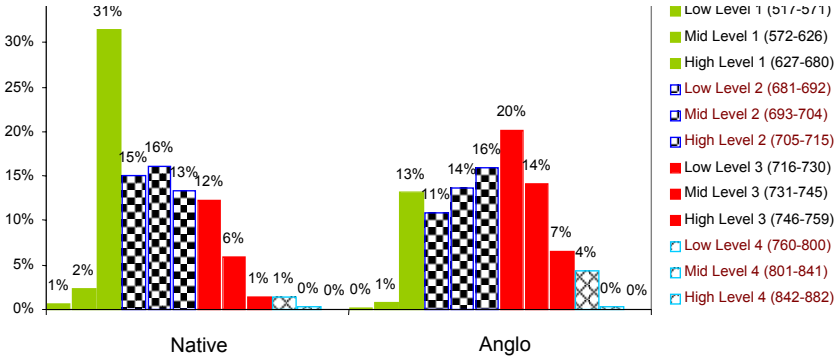
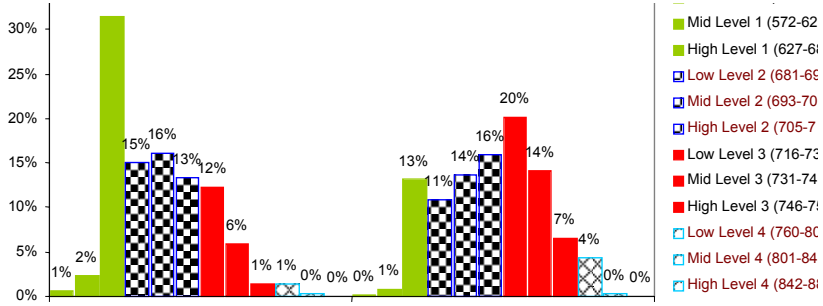


Figure 3 Percentage of eighth grade population within each assessment level in mathematics 1999-2002.



at fourth grade is 14.6. A calculation of a confidence interval, $CI_{.99} = 10.06 \leq \mu \leq 19.6$, allows us to conclude with a high degree of certainty that the average score of Anglo students is significantly higher than the American Indian students on the fourth grade assessment.

Competency Areas Proportions: In analyzing which, if any, of the seven identified mathematics competency areas contribute significantly to the gap in performance between American Indian and Anglo fourth graders, we found that both Anglo and American Indian students scored the highest in patterns and functions and modeling/representations . Although the total score percentages in these areas were disproportionate between the two groups, they were relatively equal in proportion within each group. Figure 2 shows the percentage of students performing at proficient levels (i.e., at or above 71%) in each of the competency areas. The lowest level of proficiency for both groups was number and numeration with 37% of American Indians proficient compared to 54% proficiency among Anglo students.

Competency Areas Differences: The measured difference in the proportion ($\hat{p}_A - \hat{p}_N$) of fourth grade students scoring at proficient levels (i.e., at least 71%) for each competency area is reported in Table 2 along with a 99% confidence interval for the actual difference ($p_A - p_N$) in these proportions. It is somewhat surprising to see that a gap in proficiency was measured in all competency areas between American Indian and Anglo students. Based on the confidence intervals, we can conclude with a high degree of certainty that Anglo students perform better in all competency areas than their American Indian peers, with relatively higher degrees of disparity in proficiency in reasoning, operations and measurement.

Eighth Grade

Level Comparison Proportions: Regarding a comparison of the raw scores on the eighth grade assessments, the chart in Figure 3 displays the distribution of scores by proficiency level for eighth grade. The overall scores on the eighth grade assessment for both groups are considerably lower than in fourth grade in terms of proficiency level whereas the gap in proficiency is even more significant at 25%; only 20% of American Indian and 45% of Anglo students are proficient. These are alarming results in light of the research by Degenfelder, Howard, and Boynton (2003) and Timbs (2002) which indicates that level 1 and level 2 students, approximately 80% American Indian and 55% Anglo, have a relatively small chance of passing the New York State high school mathematics exam required for graduation. In particular, according to earlier research (Degenfelder, Howard, & Boynton, 2003; Timbs, 2002), level 1 students, which constitutes 34% of American Indian students and 14% Anglo, have virtually no chance of passing the exam.

Level Comparisons Differences: Table 1 shows the difference in performance levels between eighth grade American Indian and Anglo students in terms of the average raw score on the eighth grade assessment. The measured

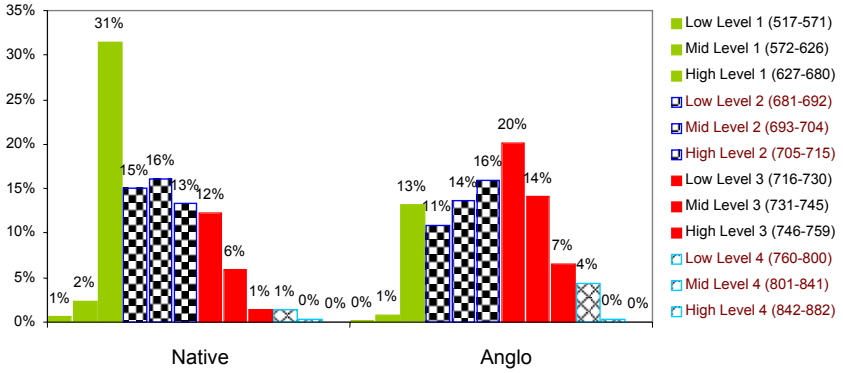
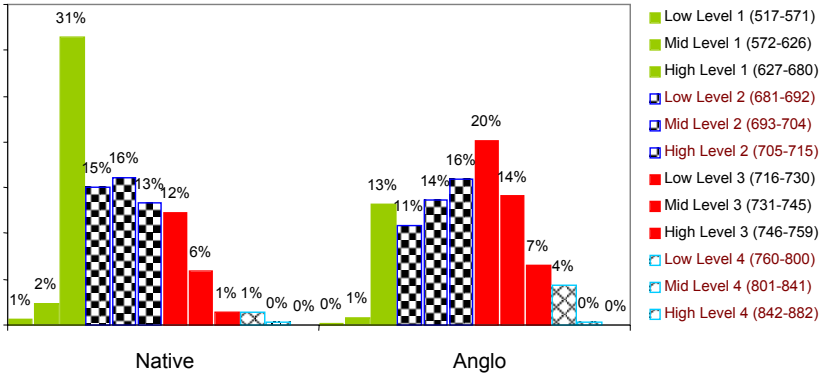


Figure 3 Percentage of eighth grade population within each assessment level in mathematics 1999-2002.

difference in average score is 20.1. A calculation of a confidence interval, $CI_{.99} = 15.2 \leq \mu \leq 25.1$, allows us to conclude with a high degree of certainty that the average score of Anglo students is significantly higher than the American Indian students on the eighth grade assessment.

Competency Areas Proportions: As in the fourth grade analysis, we found interesting results in analyzing which, if any, of the seven identified mathematics competency areas contribute significantly to the gap in performance between American Indian and Anglo eighth graders. Figure 4 shows the percentage of students performing at proficient levels (i.e., at or above 71%) in each of the competency areas. Notice that overall, the proportion of eighth graders achieving proficient levels in these competency areas is lower than the fourth graders. Moreover, on the grade 8 assessment the highest level of proficiency for both



groups was uncertainty, 24% American Indian and 34% Anglo. The lowest level of proficiency was in operations (9%) for American Indians and Measurement (20%) for Anglos.

Competency Areas Differences: The measured difference in the proportion ($\hat{p}_A - \hat{p}_N$) of eighth grade students scoring at proficient levels (i.e., at least 71%) for each competency area is reported in Table 2 along with a 99% confidence interval for the actual difference ($p_A - p_N$) in these proportions. As with the fourth grade assessment, a gap in proficiency was measured in all competency areas between American Indian and Anglo eighth grade students. The confidence intervals allow us to conclude with a high degree of certainty that although overall performance on the eighth grade assessment was lower than the overall performance on the fourth grade assessment, eighth grade Anglo students also perform better in all competency areas than their American Indian peers. The disparity in performance at proficient levels between the two groups in eighth grade is most high in the areas of modeling/representation, reasoning, and uncertainty. The disparity in performance is lowest in the area of measurement.

Observations

First, at the fourth grade level, there was a difference in proficiency of approximately 17% between the Anglos and their American Indian counterparts, whereas in the eighth grade the proficiency gap is even more significant at 25%. This is made even more striking when one observes that a smaller proportion of eighth graders are proficient as compared to the fourth grade. This is further substantiated by the competency area analyses that made an overall decrease in proficiency from the fourth grade to the eighth grade level apparent.

Second, there appears to be consistency in the proficiency gap between American Indians and Anglos for both grade levels in the areas of Mathematical Reasoning, Number and Numeration, Operations, and Patterns/Functions. However, there seems to be a "widening" of the gap in the areas of Modeling/Representation and Uncertainty from fourth grade to eighth grade. There also appears to be a substantial "narrowing" of the gap in the area of Measurement from fourth grade to eighth grade.

The "gaps" notwithstanding, the overall, relatively low performances on the assessments indicate an obvious need for some intervention to improve performance of all learners. Over the four-year period, 1999-2002, as a result of performance on these assessments, approximately 80% of American Indians are required to receive Academic Intervention Service, implying that current practice is not proving effective. A change in the core curriculum or methods of instruction may be warranted. Such intervention should be designed to address the "gap" as well as improve the performance of all learners.

Implications and Suggestions

A substantial number of studies identified by Demmert (2001) point to the positive effect on performance and academic attainment of Natives when "local

knowledge plays a dominant role in instruction (usually in combination with use of the Native language)" (p. 11). According to research cited by Strang and von Glatz (2001), American Indian/Alaska Native "students appear to do particularly well in situations where the students' culture is valued, or where Native parents are actively involved" (p. 10). Lipka (1994) suggests such success with Yup'ik in Alaska, as do Trent and Gilman (1985) for Natives in Nevada. Despite this, there exists "significant resistance" to implementing cultural-based and native language based programs by state and federal policy makers (Demmert, 2001).

Furthermore, the constructivist approaches to teaching and learning that are reflected in both National Standards and New York Standards for mathematics, are "quite harmonious" with the "American Indian ways of teaching, such as modeling and providing for long periods of observation and practice by children" (Nelson-Barber & Estrin, 1995). Given this and the results of the present study, we propose suggestions to help improve the mathematics performance of the American Indian children of Western New York. Specifically, we suggest improved professional development of mathematics teachers in the four schools from which this data came, an expansion of an after school program that already exists, and curriculum development steeped in Native culture and grounded in constructivist approaches and effective mathematics teaching and learning strategies.

Providing professional development to both preservice and inservice teachers who teach American Indians/Alaska Natives should include workshops for the development of interactive lessons that draw on real-world application of mathematics and project oriented approaches. Well identified effective strategy for mathematics instruction for all learners include creating a mathematical environment, posing worthwhile mathematical tasks, using cooperative learning, using models and technology as thinking tools, encouraging discourse and writing, and requiring student justification of responses (Van de Walle, 2004). In particular, for American Indian/Alaska Native students, cooperative learning may prove exceedingly beneficial for promoting learning (Little Soldier, 1989). Helping teachers to better incorporate this and the other strategies would benefit all learners and consequently close the gap.

For example, teachers could address the widened "gap" revealed in this study for Modeling/Representation. Curricular and instructional interventions may include the use of American Indian/Alaska Native culture as a context for mathematics concepts (providing a meaningful mathematics environment), as well as cooperative learning and posing worthwhile mathematical tasks. A study by Hankes, Whirlwind Soldier, and Davis (1998) found that the native language of Lakota and Oneida represented base-10 concepts more meaningfully than English. In developing mathematics understanding, learners who are capable of connecting new ideas meaningfully to many existing ideas are said to have "relational understanding" (Van de Walle, 2004, p. 25). Learners who can "re-represent" concepts in multiple ways tend to have deeper conceptual understanding. Curriculum that focused on the development of base-10

numeration by comparing the way our current system groups by ten to the way the American Indians of Western New York culture represent numbers is one way to provide opportunity to "re-represent." The comparison itself has potential to facilitate other culturally appropriate ways of representing mathematics ideas. This could improve the relational understanding of both American Indians/ Alaska Natives and Anglos.

Taking the work of Barta, Abeyta, Gould, Galindo, Matt, Seaman, and Voggessor (2001) as an example, working directly with American Indian leaders can identify how mathematics is used and how it reflects their culture to develop activities integrating American Indian culture and knowledge of mathematics with effective teaching and learning strategies. With such information provided by American Indian leaders regarding cultural mathematics uses, the curricula for after-school programs, such as the Early Childhood Learning Center (ECLC) in Irving, NY, who are dedicated to helping these learners achieve proficiency in the mathematics areas for which they have shown deficiency, could be further developed.

Moreover, steps should be taken to offer assistance to American Indian/ Alaska Native communities in creating effective learning environments that include a sense of belonging and security that is accessible to all American Indian/Alaska Native students. Because the demographics of the present study revealed that for the four-year period measured in this study, 64% of Native students belonged to low-income families compared to 30% of Anglo students based on reduced or free lunch data, there is need for such environments or programs must address basic needs such as access to food, clothing, and health care along with cultural mentorship coupled with an effective curriculum and specific poverty training (Payne, 2001).

Recommendations

The data as presented clearly indicate a "gap" in competence between American Indian and Anglo learners in Western New York. We recognize a need for further study into these disparities in competence as measured by the state assessments to determine how well these assessments actually reflect Native learners' abilities and concepts.

We envision developing creative curricula that include interdisciplinary and interactive coursework in Native culture and traditional academic subject areas, and in which an academic coordinator would be charged with the training of tutors and teachers aides. Such coordinators should be certified in content and certified to work with students from low-income families (Payne, 2001). Two sources of tutors and aides could be successful high school Native students and pre-service teachers from area colleges with appropriate training and supervision. Such programs should emulate many of the positive attributes of the successful SUNY Fredonia Science and Technology Entry Program (STEP) such as career related field trips, exam review sessions, workshops addressing study skills, and the development of positive support groups (http://www.fredonia.edu/step).

The suggestions for professional development, instructional programs, and curriculum development that we have provided warrant further development and detail. However, they do adhere to the spirit of the recommendations from Demmert (2001) and Strang and von Glatz (2001). It is our belief, that through cooperation with the American Indian community, we can address these disparities in meaningful ways to achieve greater success in mathematics for American Indian learners.

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