School and Contextual Influences on Rural Student Academic Success

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The research reported here was supported by a grant from the Rural School and Community Trust. The opinions expressed are those of the authors and do not represent views of the Rural School and Community Trust.

Background

The research we have conducted at the STAR (Service To All Relations) School in rural northern Arizona has been focused on young Navajo children, specifically age 3 to grade 3. Last year that included 80 children. Ninety-eight percent of our students are Native American and come from a high poverty area (80% of children qualify for free or reduced lunch) on and near the Navajo Nation. The Navajo culture is still very much alive in our area, and the interface our students confront daily of Navajo and mainstream American culture informs a great deal of what we do and how we do it. The STAR School is a charter school specifically designed to weave Navajo cultural values into the daily life of the school. This automatically made the ecological variables of this school different from many other schools serving Native children on reservations because it didn't have the historical patterns of the Bureau of Indian Affairs and state-sponsored public schools that tended to ignore or even downgrade tribal cultural values in school organization and context. In our seven years of program evaluation research about our STAR approach to early childhood education, we have focused on math in particular and on science as a related domain, and we have extended the math research beyond preschool to include kindergarten through grade 3.

We had two research questions:

First, do Navajo 3- and 4-year-old preschoolers who are exposed to the STAR adaptation of Montessori pedagogy demonstrate educationally meaningful gains in science and math skills? The STAR Montessori adaptation integrates Navajo cultural values and employs three languages in the classroom: English, Navajo, and American sign. STAR also integrates ideas from recent scientific literature on math development and math education.

Second, when STAR'S Montessori pedagogy is extended from the preschool into classroom instruction in kindergarten through grade 3, are there significant gains in math performance among Navajo children at each grade level?

For now, both of these questions are addressed with descriptive statistics that reveal clear patterns. We believe the STAR program effects are strong enough to reach statistical significance in our small sample. Our future analyses will be inferential, including longitudinal techniques.

Purpose in focusing on math in early childhood

Siegler (2009) and others have pointed out that a child's math skill upon entering school is a most powerful predictor of later reading and math success. Further, children from low-income backgrounds enter school with much less mathematical skill than children from higher income levels, and these deficits are often difficult to change (Ramani & Siegler, 2011), even more difficult than in other academic areas. Mathematics is a hierarchical domain; early foundational concepts are necessary for later learning. The variation among entering Navajo preschoolers in math development is stunning. In April 2013, we welcomed a typical group of 22 preschoolers that includes four children who score at a math age-equivalent below 2 years of age while three other children enter at an age-equivalent of 5 ½ years of age or higher.

The STAR model of early math and science education now has a base of some seven years of program evaluation research, albeit assessing a small number of children (averaging 21) per year. The first two years featured implementation of the Montessori program in the preschool classroom and gradual acquisition of materials. In the next three years we merged the preschool and kindergarten classrooms and added research-based materials and practices (e.g., math number lines). Our Montessori math program now included the first three years of school (two preschool years and kindergarten) for some children and was spreading into the first/second grade classroom. As we enhanced program fidelity and intensity in the recent three years, students' outcomes began to demonstrate promise that we have a "best practices" model for Native American schools and communities. We believe that other schools can benefit from STAR's experience and more quickly implement similarly successful programs.

Research process, procedures, and results

As part of a larger assessment battery, annual before/after, standardized, quantitative evaluation measures of the children's initial math and science conceptual development were gathered via the DIAL 3 Concepts subtest and the Woodcock-Johnson III Mathematics subtests 18a (concepts) and 18b (sequences). Both assessments are interactive and were well received by the children, including 3-year-olds. The children accompanied the program evaluator to a separate room for testing. The results of the recent four years will be presented.

In each of the three years for which data were available on the DIAL 3 Concepts subscale (Table 1), scores improved substantially between fall and spring. The improvement was clear in changes in both group average and in number of individual children achieving substantial change. The group average, expressed as either standard scores or percentiles, moved from below the national norms in the fall to well above the norms in the spring. The groups' successes did not depend on just a few children doing exceptionally well. In each year approximately 75% of the students in preschool passed the strict Government Performance Results Act (GPRA) standards for individual improvement. In summary, each preschool cohort was behind in science in the fall and ahead of the norms by spring.

The math effects appear to be even stronger. Each of the recent four preschool cohorts began the year well behind the age norms for the Woodcock-Johnson III math scales (Table 2). By the end of the year the children in these cohorts typically gained 17 months on their average "test age equivalence" scores in just 10 months of school (the Woodcock does not provide standard scores for these subscales). The most recent cohort ended the year with a test-age score a half-year ahead of their average chronological age. All but one of those children scored at the entry level for kindergarten or higher. It is noteworthy that last year's cohort was the first to enter STAR Preschool with an average test age close to their chronological age, but their gains over the year nevertheless matched those of previous cohorts. (There are no GPRA standards for math.)

STAR's math intervention now meets its goals at the preschool level, but is it also related to successful math learning in subsequent grades? Trends in Woodcock-Johnson scores for children in preschool through grade 3 last year suggest that the math intervention effects are related to math success in grades after preschool (Table 3). Note that in the table preschool now is broken into two cohorts, one of which is 3-year-olds who just entered the program and will stay for two years. Both preschool age cohorts gained substantially in math scores, achieving average scores that match or exceed the entry score for kindergarten. Looking beyond preschool, the average spring Woodcock scores for grades kindergarten through grade 2 all meet or exceed the normative Woodcock entry score for the next grade. Of the 37 students in these grades, 28 met or exceeded the entry score. The third grade comprises students who did not experience the fully developed STAR Preschool math program of the last three years. Their weaker Woodcock

performance may reflect that gap. Data in the coming years may clarify the relationship between the Preschool program and later math performance.

Discussion

Based on STAR School's initial promising findings, the Rural Trust decided in 2011 to support our plan to develop training DVDs about our approach that allow other schools to consider implementing the program. Several of the DVDs have been developed and are now on STAR School's website (starschool.org). They are free for any rural school to access.

A second discussion topic is the dissemination of your findings and ours as we assess our programs' outcomes. What wisdom do we have among us about how and where to publish our results with indigenous/rural-serving schools, results that will necessarily be limited by small samples and by non-random assignment of children to school experiences?

References

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