

Math Out of the Box[®]

Fulfilling the mathematical promise that exists
in every child

Gains in Achievement in South Carolina in 2007-2008

Background Information

Math Out of the Box [Moss, 2005] is an inquiry-based mathematics curriculum for kindergarten through fifth grade, which was completed in the spring of 2008 by a team of researchers in the Department of Mathematical Sciences, College of Engineering and Science at Clemson University. Since 2005, the Math Out of the Box team has worked with school districts in South Carolina and other states to implement each of the four strands of Math Out of the Box along with a companion professional development program. These research projects have been funded by corporate partners, foundations, and state and federal grants.

This report examines changes in instructional practice and student achievement in 32 Title I schools in South Carolina. By the school year 2007/2008, 12 of these schools implemented the algebra/data analysis, geometry, and measurement strands, which represent one-half year's instruction. By adding the numbers strand in 2008-2009, these schools will have a full implementation. In this report these schools are referred to as MOOTB schools. Only schools with a perceived average or above average level of fidelity of implementation were recognized as Math Out of the Box schools. Fidelity was determined by qualitative and quantitative methods, which included survey results, classroom observations, professional development reflections, and interviews with curriculum leaders. Each year a comparison was made to the Title 1 schools in the same districts that had not implemented Math Out of the Box. They are referred to as non-MOOTB schools.

Changes in instructional practice are examined using an instrument that allows teachers to retrospectively examine their own roles and those of their students. 175 teachers in the 12 MOOTB schools participated in this study. Student achievement is measured using the South Carolina Palmetto Achievement Challenge Test and compares the same MOOTB and non-MOOTB schools.

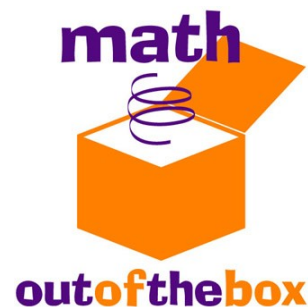
Changes in Instructional Practice

The final report of the National Mathematics Advisory Panel [US Department of Education, 2008, p.35], reports that, “Substantial differences in mathematics achievement of students are attributable to differences in teachers. Teachers are critical to students’ opportunities to learn and to their learning of mathematics.” The report lists the following descriptions of differences that impact “the effectiveness of mathematics teachers in generating achievement gains.

- Differences in teachers account for 12% to 14% of total variability in students’ mathematics achievement gains during an elementary school year.
- When teachers are ranked according to their ability to produce student achievement gains, there is a 10 percentile difference across the course of a school year between achievement gains of students in top-quartile teachers versus bottom-quartile teachers.
- The effects of teachers on student achievement compound dramatically if students receive a series of effective or ineffective teachers.”

The Math Out of the Box team designed the curriculum and the companion professional development program with the goal of changing teachers’ instructional practice and mathematics content knowledge. One instrument used by the research team to measure change, developed by Dr. Donna Diaz, was entitled *Five Dimensions of Instructional Practice*. In the instrument, “each dimension is defined in terms of traditional and inquiry-based parameters.” [Diaz, 2004, p. 20]

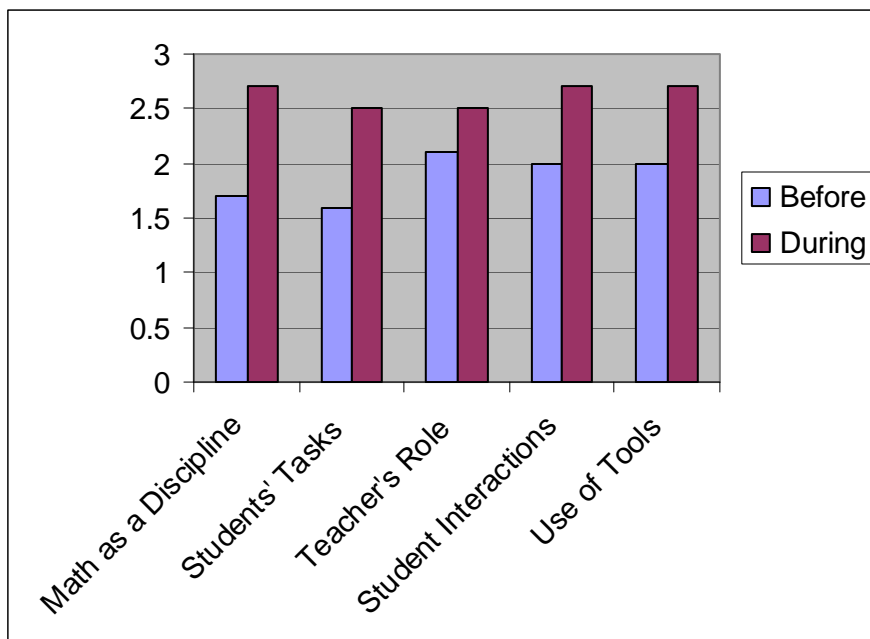
The *Five Dimensions of Instructional Practice* was used to create a survey instrument in which teachers rated how often, on a three point scale, their students accomplished particular tasks. The number 1 on the scale represented rarely or never seen behaviors, number 2 represented often or sometimes seen behaviors, and number 3 represented regularly exhibited behaviors. In the survey, the teachers retrospectively rated the instructional tasks before their use of Math Out of the Box and during the use of the curriculum.



The first dimension of practice measured in the survey is teachers' conceptions of math as a discipline. In the Math Out of the Box Survey this dimension was measured with statements about multiple representations, conjectures, and development of general mathematical rules. The second dimension has teachers examine students' problem solving strategies. The third dimension examines the roles of a teacher including facilitator, questioner, and co-learner. The fourth dimension measures students' confidence in their own learning. The fifth dimension examines the use of manipulatives and other tools in the classroom.

Following is a graph indicating the changes that teachers self-reported comparing their practices before and during the implementation of Math Out of the Box curriculum. By the 2007/2008 school year, most of the 175 teachers represented in the graph taught three strands of Math Out of the Box, adding a strand of the curriculum each year.

Teachers' Self-Reported Change in Instructional Practices From Traditional to Inquiry-Based



Student Achievement

The next set of tables compares South Carolina's Palmetto Achievement Challenge Test (PACT) proficient and advanced scores for the schools in this research project.

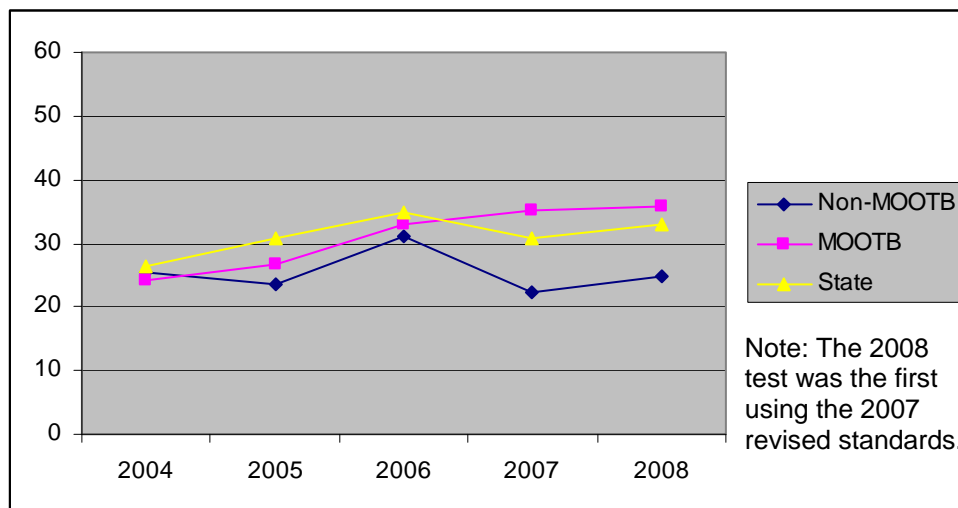
Non-MOOTB (line with rhombuses): Represents proficient and advanced scores of students in 20 schools taught mostly by teachers using other curricula. Fifty percent or more of the students are demographically below poverty and few or no teachers are

implementing Math Out of the Box. The 2008 results represent about 1,500 students per grade.

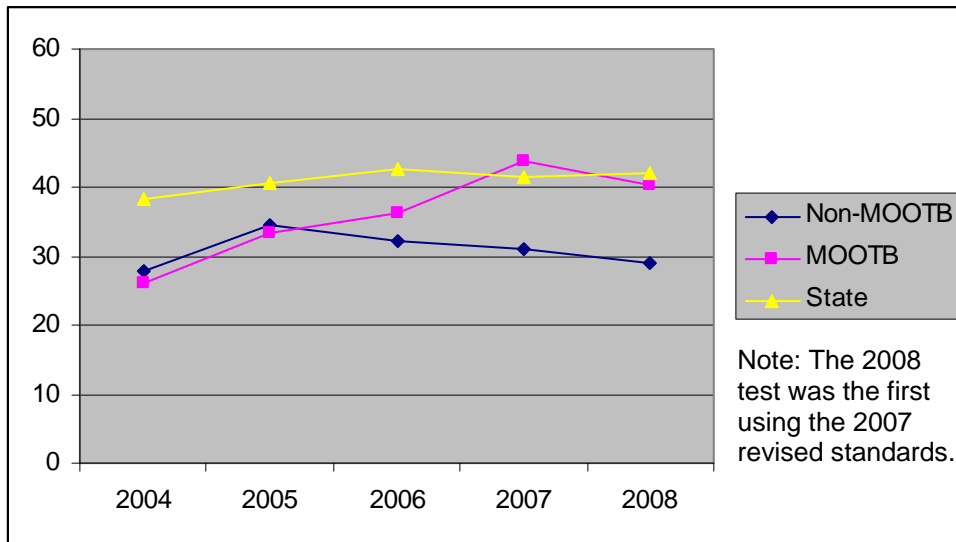
MOOTB (line with squares): Represents proficient and advanced scores of students in 12 schools taught mostly by teachers using Math Out of the Box. Fifty percent or more of the students are demographically below poverty. In 2004, teachers each taught one module of Math Out of the Box. By 2007, most of the participating teachers taught three modules of the curriculum. The 2008 results represent about 900 students per grade.

State (line with triangles): Represents average proficient and advanced scores of all South Carolina students in each of the third, fourth, and fifth grades.

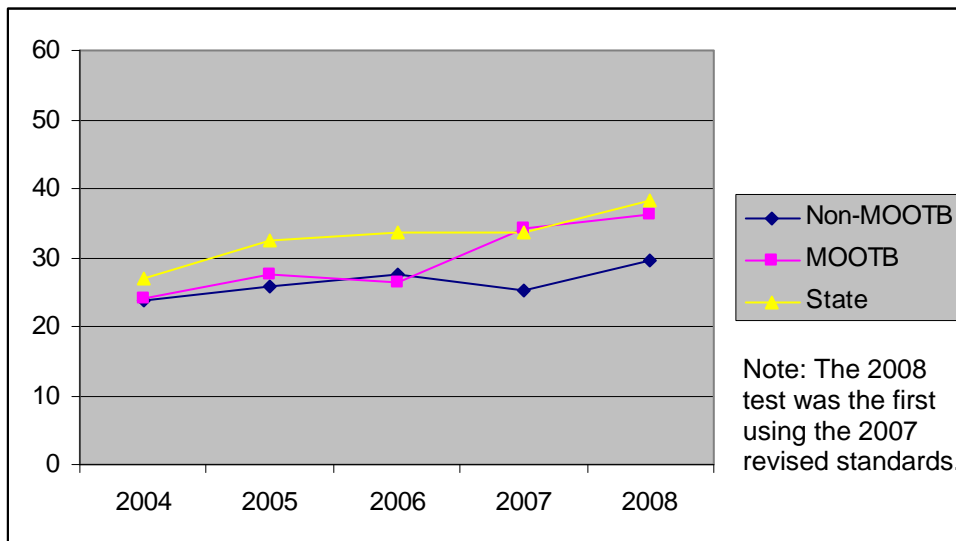
Achievement Results for Proficient and Advanced from 2004 to 2008 Third Grade



Achievement Results for Proficient and Advanced from 2004 to 2008 Fourth Grade



Achievement Results for Proficient and Advanced from 2004 to 2008 Fifth Grade



Concluding Remarks

Teachers implementing the Math Out of the Box curriculum experienced gains in student achievement with more students reaching the proficient and advanced levels than other Title 1 schools in their districts. The teachers self-reported changes in their

roles and those of their students, showing a transition from traditional to more inquiry-based practices.

Over time, as more modules were implemented, the MOOTB schools matched students representing all types of schools. Although the data available for schools that are not Title 1 and implementing Math Out of the Box are limited, early results show proficient and advanced levels of achievement greater than state averages.

The Math Out of the Box research team anticipates working with many more schools and districts to increase student achievement through change in the teaching and learning of mathematics. Questions which now can be posed as a result of this report include the following:

- Why did the fifth grade scores take longer to change?
- What will data show after a full implementation of Math Out of the Box?
- As more non-Title 1 schools adopt Math Out of the Box, how will student achievement in those schools be impacted?
- Are the differences indicated on the graphs significant?
- What components, if any, of the Math Out of the Box curriculum play a role in the transition from tradition to inquiry-based practices?

For more information about research-based professional development for Math Out of the Box, email the Clemson University research team at mootb@clemson.edu, call 864-656-1720, or visit mathoutofthebox.org.

For more information about adoption of Math Out of the Box, email Nichole Hall Nichole.Hall@carolina.com, Math Out of the Box, Program Manager, Curriculum Division, Carolina Biological Supply Company, call 336-538-6252, or visit carolinacurriculum.com.

References

Diaz, D. P. (2004). The role of standards-based curricula in teacher learning and instructional reform. Unpublished doctoral dissertation. Clemson University.

Moss, D.A., Diaz, D.P., & Moss, W.F. (2005). About Math Out of the Box. *Center of Excellence in Science and Mathematics Education, Clemson University*. Retrieved September 23, 2008, from <http://www.mathoutofthebox.org/research/about.shtml>.

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US Department of Education (2008), *Foundations for Success: The Final Report of the National Mathematics Advisory Panel*.