

Summary of Quantitative Research on the Impact of DMI

Developing Mathematical Ideas (DMI) is a nationally disseminated professional development curriculum designed to help K-8 teachers develop the knowledge and skills required for teaching mathematics for understanding. The first goal is to help teachers learn in a profound way the content they are responsible for teaching. This includes understanding the content for themselves, recognizing how the content of their grade is situated in the trajectory of learning from Kindergarten through middle school, building connections among different concepts, and being able to analyze student thinking from a mathematical perspective. DMI is intended to help teachers reorient their instruction to focus on mathematical goals and develop a new kind of mathematics pedagogy in which student understanding takes center stage.

A recent study of more than three hundred teachers at ten sites across the country reports that those who participated in high-fidelity DMI seminars demonstrated significantly increased mathematics knowledge for teaching. This finding was consistent across two assessments given to DMI participants and a control group. These results are supported and extended by reports from school systems that have incorporated DMI as a major professional development component in system-wide mathematics improvement programs. The districts' reports highlight teacher learning and improved student-learning outcomes.

This document provides more information about quantitative studies of the impact of DMI on teachers' mathematics knowledge and subsequently, on student achievement.

Evidence of DMI's impact on teacher learning

Courtney Bell and colleagues conducted a study to assess the growth of mathematical knowledge for teaching¹ of DMI participants (Bell et al, <paper needs to be posted>). Teacher learning was measured with two instruments: multiple-choice items developed by the Study of Instructional Improvement (SII) and open-ended items developed primarily from assessments previously used by the DMI staff. After controlling for pretest scores on both assessments of 311 teachers at 10 sites, a hierarchical linear model indicated that DMI participants outperformed the comparison group by a statistically significant margin on both the multiple choice assessment and the open-ended assessment. In this study, the breadth of

¹ *Mathematics knowledge for teaching* refers to the mathematical knowledge used to carry out the work of teaching mathematics – for example, assessing students' mathematical work, representing numbers and operations in the context of instruction, or explaining common mathematical rules or procedures. See Hill, H., Schilling, S., & Ball, D. (2004). Developing measures of teachers' mathematics knowledge for teaching. *The Elementary School Journal*, Volume 105, #1.

facilitators' opportunities to learn about DMI² appeared to have an impact on the magnitude of the differences between the treatment and comparison groups on the open-ended assessment.

Georgia State University recently collected data about the efficacy of a 2-year professional development course offered through the Northeast Georgia Regional Educational Service Agency (NEGA RESA), of which DMI was a significant component.³ The August 2008 RESA Report on the K-2 Mathematics Initiative highlights statistically significant teacher gains from the pre-test to the post-test on the SSI/Learning Mathematics for Teaching measures administered to K-2 teachers who enrolled in the course.

As documented in a 2005 study by Hill et al, there is a correlation between teachers' mathematical knowledge for teaching and student achievement in mathematics (Hill, Rowan, & Ball, 2005). In their study, Hill and colleagues report that teachers' mathematical knowledge for teaching, as reflected in scores on the SII instrument, positively predicted student gains in mathematics in both grades studied (first and third). That is, this study links the results described here to student achievement.

Evidence of DMI's impact on student achievement

Several studies indicate directly that participation in DMI leads to improved student learning.

In 2000, Boston Public Schools (BPS) implemented an Elementary Math Plan, which included the use of a new curriculum, professional development, system-wide assessments, and the introduction of mathematics coaches. BPS has reported gains in student achievement as they relate to teachers' developing their mathematics knowledge for teaching through participating in DMI (Noyce Foundation Phase I 2006 Report, unpublished). After controlling for student demographic characteristics:

² In the absence of independent measures of facilitator knowledge and skill, the researchers used facilitators' engagement with a variety of activities (breadth of opportunities to learn) as a proxy for the degree to which they understood the goals of DMI. They looked at whether the facilitator had: attended the leadership institute at Mount Holyoke College or at another location; apprenticed to another facilitator; co-facilitated and/or taught at the Mount Holyoke leadership institute; participated in a study group of other facilitators; written cases about their facilitating; been observed by others; and/or participated in other non-DMI leadership training.

³ The course for K-2 teachers began with a year of work on Cognitively Guided Instruction based on the book *Children's Mathematics: Cognitively Guided Instruction*, by Thomas P. Carpenter, Elizabeth Fennema, Megan Loef Franke, Linda Levi, and Susan B. Empson (1999). This was followed by a second year centered on work with the *Building a System of Tens* DMI module, and augmented by other work on the assessment of problem types, strategy, flexibility, and base-ten understanding, through inquiry into observations of the instructor's demonstration lessons. (Personal correspondence, Stephanie Smith, 2008)

- Fourth grade students with two consecutive years of instruction by a Math Plan teacher (i.e., who had completed at least three DMI seminars and a curriculum institute) scored significantly higher on the MCAS (Massachusetts Comprehensive Assessment System) than students who did not have a Math Plan teacher in either year.
- Over time, schools in which teachers participated in Math Plan professional development performed better than would be predicted if the teachers had never participated in Math Plan professional development.⁴

A 2007 study reported that, since the implementation of the Boston Math Plan (2000-2007), annual NAEP results reveal consistent increases in student achievement in mathematics at all elementary and middle school levels in the Boston Public Schools (Lutkus & Weiss, 2007).

Furthermore, the following sites that have used DMI extensively have reported quantitative evidence of the positive impact that teachers' enrollment in DMI has had on student performance on state tests:

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| Northeast Georgia Regional Educational Service Agency (GA) | CRCT (Criterion-Referenced Competency Tests) |
| Shoreline School District (WA) | WASL (Washington State Assessment of Student Learning) |
| Lake Washington School District (WA) | WASL (Washington State Assessment of Student Learning) |
| Provo City School District (UT) | U-PASS (Utah Performance Assessment System for Students) |
| Jordan School District (UT) | U-PASS (Utah Performance Assessment System for Students) |
| Albuquerque Public Schools (NM) | NMSBA (New Mexico Standards Based Assessment) |

In each case these districts report rises in student mathematical achievement on the state test in the classrooms of teachers taking DMI. A statistical analysis of Albuquerque Public Schools student scores on the 2002 NMSBA further noted that the effect was particularly strong among students with learning disabilities (Little-Kaumo, 2002).

Additional Lessons Learned

Lesson 1 – DMI facilitators who engage in their own relevant professional development learn to facilitate DMI seminars effectively. Teachers in seminars

⁴ Whereas the trendline established in the three years *before* any of the teachers had first participated in Math Plan professional development was essentially flat, *after* teachers began participating in Math Plan professional development, on average, their schools scored higher than projected.

led by facilitators who have a deep understanding of DMI learn more than those who work with facilitators with less experience of DMI (Bell, Wilson, & Higgins, in press).

Lesson 2 – It is important to embed DMI within thoughtful and comprehensive plans for improvement of the entire mathematics program, including curriculum, instruction, and assessment. For example, since 2000, Boston Public Schools has been enacting a Math Plan that includes teachers using a standards-based math curriculum, a comprehensive program of professional development for teachers and administrators, a system of formative assessments designed to monitor and inform instruction, and school-based support from math coaches.