SYMPOSIUM: MIDDLE SCHOOL MATHEMATICS PROFESSIONAL DEVELOPMENT IMPACT STUDY

Paper #1: Middle School Mathematics PD Study: Study Design and Methodology

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*Presenter

Background/context:
Student achievement in mathematics has been a focal concern in the United States for many years. The National Research Council’s 2001 report and the recent report of the National Mathematics Advisory Panel (2008) both called attention to student achievement in mathematics, and both called for all students to learn algebra by the end of eighth grade. Reports have argued, further, that achieving this goal requires that students first successfully learn several topics in rational numbers—fractions, decimals, ratio, rate, proportion, and percent. These topics are typically covered in grades 4 through 7, yet many students continue to struggle with them beyond the seventh grade. The PD program evaluated in this study is designed to address the problem of low student achievement in topics in rational numbers. The study focuses on seventh grade, the culminating year for teaching those topics.

Currently, through the Elementary and Secondary Education Act, the federal government provides significant resources for PD, but little rigorous evidence is available on the impact of PD on teacher and student outcomes. Hundreds of studies have addressed the topic of teacher learning and PD (for reviews, see Borko 2004; Clewell, Campbell, and Perlman 2004; Kennedy 1998; Richardson and Placier 2001; Supovitz 2001; Yoon, Duncan, Lee, Scarloss, and Shapley 2007). The most recent review of studies of the impact of teacher PD on student achievement revealed a total of nine studies that have rigorous designs—RCTs or certain quasi-experimental designs—that allow causal inferences to be made (Yoon et al. 2007). Four of the nine studies focused on the effect of a PD program on mathematics achievement, and none focused on mathematics at the middle school level.

Purpose / objective / research question / focus of study:

The Middle School Mathematics PD Impact Study is the first rigorous test of the impact of a PD program focused on teachers of middle school mathematics. The study has three central research questions:

1. What impact did the PD program provided in this study have on teacher knowledge of rational number topics? Teacher knowledge was measured in the fall and in the spring using a specially constructed teacher knowledge test. The test was designed to measure two constructs aligned with the purpose of the PD program: knowledge of rational numbers content typically taught in seventh grade (common knowledge of mathematics, or CK) and additional knowledge that may be useful for teaching rational number topics (specialized knowledge of mathematics for teaching, or SK). Each form was equally
divided between CK and SK and equally divided between: (1) fractions and decimals and (2) ratio, rate, proportion, and percent.

2. What impact did the PD program provided in this study have on teacher instructional practices? To measure instructional practice, one classroom observation was conducted for each teacher when they were teaching rational number topics. The observations produced three primary measures of instructional practice: teacher elicits student thinking, which encompassed such behaviors as asking other students whether they agree or disagree with a student’s response; teacher uses representations, which counted the number of times the teacher explained a visual representation of mathematics, and teacher focuses on mathematical reasoning, which counted the number of times the teacher asked questions such as “Why does this procedure work?” or “Why does my answer make sense?”

3. What impact did the PD program provided in this study have on student achievement in rational number topics? A customized, computer-adaptive student achievement test was constructed for the study by a major test publisher. The test was restricted to positive rational numbers content and drew on a customized item base that contained nearly 1,200 rational numbers items.

Setting / Population / Participants / Subjects:

The study randomly assigned 77 mid- and high-poverty schools from 12 districts to treatment and control conditions and collected outcome data on teachers and students. The PD was delivered by two provider organizations, each of which worked with half of the participating districts. Seventh-grade teachers in the treatment schools had the opportunity to receive the PD program offered by the study and could also continue to participate in the PD activities that they would have received in the absence of the study. Seventh-grade teachers in the control schools received only the PD that they would have received in the absence of the study.

Intervention / Program / Practice: (See paper 2 in this symposium)

Research Design:

The study randomly assigned 77 mid- and high-poverty schools from 12 districts to treatment and control conditions and collected outcome data on teachers and students. The PD was delivered by two provider organizations, each of which served the treatment schools in six of the 12 participating districts. Seventh-grade teachers in the treatment schools had the opportunity to receive the PD program offered by the study and could also continue to participate in the PD activities that they would have received in the absence of the study. Seventh-grade teachers in the control schools received only the PD that they would have received in the absence of the study.

Data Collection and Analysis: (See Paper 3 for a more detailed description of analysis)
Data were collected from teachers and students in the study schools in the fall, winter, and spring of the 2007–2008 school year. We also gathered background data on the amount and type of PD teachers participated in during the study. Study staff obtained information on the implementation of the PD by observing the institute and seminars and by reviewing logs maintained by coaches that recorded the nature of each coach interaction with each teacher.

Data were also collected to document the total amount and type of mathematics-related PD (including study PD and other PD) that teachers participated in during the first year of the study. Study staff also obtained information on the implementation of the study PD by observing the institute and seminars and by reviewing logs maintained by coaches.

The basic analytic strategy for assessing the impact of the PD program was to compare outcomes for schools that were randomly assigned within each district to each of the two study conditions. Because we used data on students nested within teachers’ classrooms nested within study schools, three-level models were used to estimate the impact of professional development on student achievement and two-level models were used to estimate impact on the teacher measures.

**Findings / Results:** (See paper 3 in this symposium)

**Conclusions:** (See paper 3 in this symposium)
**Paper #2:** Middle School Mathematics PD Study: Description of the PD Intervention

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*Presenter

**Background/context:** (See paper 1 in this symposium)

**Purpose / objective / research question / focus of study:** (See paper 1 in this symposium)

**Setting / Population / Participants / Subjects:** (See paper 1 in this symposium)

**Intervention / Program / Practice:**

This paper describes the PD program that was delivered during the first year of the study. The main goal of the intervention was to increase teachers’ capability to teach positive rational number topics effectively. The program included a 3-day summer institute (18 hours per teacher), five 1-day seminars held during the school year (30 hours per teacher), and 10 days of intensive in-school coaching (20 hours per teacher), providing a total intended dosage that is significantly higher than the dosage of content-focused PD most mathematics teachers typically receive in a single year (Birman et. al, 2007).

Within the domain of rational numbers, the program design focused on fractions, decimals, ratio, rate, proportion, and percent. Across the 8 institute and seminar days, the program was designed to provide equal coverage to fractions and decimals (4 days) and ratio, rate, proportion, and percent (4 days). For each rational number topic area, the PD program was designed to address both common knowledge of mathematics and specialized knowledge of mathematics for teaching.

Two providers selected through a competitive process delivered the PD program. The study design required both PD providers to deliver the same intended dosage and to adhere to a common set of objectives, rational number topics, and PD features, described in more detail below. But because the providers built on their existing materials addressing topics in rational numbers, the providers differed in how they planned to structure teacher learning activities and present the content to teachers.

The summer institute and seminars blended activities intended to develop specialized knowledge of mathematics for teaching and strengthen common knowledge of mathematics. To address the common knowledge goals, the program design emphasized using precise definitions and explicating the properties and rationales underlying common procedures used with rational numbers. To address the specialized knowledge goals, the PD emphasized developing teachers’ explanations of rational number concepts and procedures, identifying and addressing persistent student misconceptions, and using representations of rational number concepts in teaching. The
design called for modeling and practicing relevant pedagogical techniques as a means to develop teachers’ skills in implementing specific mathematics teaching strategies.

The primary purpose of the coaching component of the PD program was to help teachers apply material covered in the institutes and seminars to their classroom instruction. The coaching component was designed to consist of 10 days of coaching provided through 5 two-day visits to each school. Each two-day coaching visit was intended to immediately follow one of the five seminar days and to link to the preceding seminar. Both providers used their districts’ curricular pacing guides to schedule coaching visits when teachers planned to teach rational number topics.

**Research Design:** (See paper 1 in this symposium)

**Data Collection and Analysis:** (See paper 1 in this symposium)

**Findings / Results:** (See paper 3 in this symposium)

**Conclusions:** (See paper 3 in this symposium)
Paper #3: Middle School Mathematics PD Study: Study Results

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Background/context: (See paper 1 in this symposium)

Purpose / objective / research question / focus of study: (See paper 1 in this symposium)

Setting / Population / Participants / Subjects: (See paper 1 in this symposium)

Intervention / Program / Practice: (See paper 2 in this symposium)

Research Design: (See paper 1 in this symposium)

Data Collection and Analysis: (See paper 1 in this symposium)

Findings / Results / Conclusions:

This paper will describe results concerning the impact of the PD on the three primary study outcomes: teacher knowledge of rational number topics, teacher instructional practices, and student achievement in rational number topics.

The basic analytic strategy for assessing the impact of the PD program was to compare outcomes for schools that were randomly assigned within each district to each of the two study conditions. Because we used data on students nested within teachers’ classrooms nested within study schools, three-level models were used to estimate the impact of professional development on student achievement and two-level models were used to estimate impact on the teacher measures. The impact model used the sample of teachers and students present in the study schools as of the spring 2008 data collection period. The estimates provide an intent-to-treat analysis of the impact of the PD program because they reflect impact on the targeted (or “intended”) sample, whether or not all eligible teachers in the treatment schools participated fully in the PD provided.

The impact of the PD was examined for the full sample (12 districts) and for key subgroups of districts. The subgroups were formed by design during the recruitment phase of the study. First, we recruited districts that were using different mathematics curricula. We recruited six districts that used either Glencoe McGraw-Hill Mathematics: Applications and Concepts or Prentice Hall Mathematics (referred to jointly as Glencoe/PH Mathematics); we also recruited 6 districts that used Connected Mathematics (CMP). These two categories of curricula differ in the organization of instructional materials, in the instructional approaches supported, and in the content emphasized, so the impact of the PD may differ by curriculum type.

In addition to examining the impact of the PD separately for each curriculum subgroup, we also examined the impact separately for each of the two organizations that provided the PD. Each of the two PD providers—America’s Choice and Pearson Achievement Solutions—was assigned to work with 6 of the 12 districts participating in the study. Providers were assigned to
districts to balance the allocation of districts using Glencoe/PH Mathematics and CMP across providers. Thus, the 6 districts using Glencoe/PH Mathematics were split between the two providers (three for America’s Choice and three for Pearson Achievement Solutions), and the six districts using CMP were similarly split, so that the effect of the PD in either curricular context would be derived from the services of both organizations.

All analyses are completed. However, the results cannot be shared at this time because the report is currently under peer review in the Institute of Education Sciences. The complete first year report is scheduled to be released fall of 2009, well before the SREE conference.
Appendix A. References


