Improving the Mathematical Content Base of Lesson Study
Summary of Results[i]
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Two hundred thirteen teachers and 1,059 students from 27 U.S. school districts participated in a randomized controlled trial of lesson study, with or without a resource kit on fractions. Lesson study is a form of professional learning in which teachers collaborate to study the academic content of the curriculum and conduct cycles of inquiry focused on enactment, observation, and analysis of learning during actual classroom lessons. The resource kit on fractions, developed for this project, included mathematics tasks to solve and discuss (along with related student work); curriculum materials, lesson plans and video (from Japan and from U.S. research studies); research articles; and a suggested process for investigating these materials. Lesson study groups were randomly assigned to one of three research conditions – 1) lesson study with the fractions resource kit; 2) lesson study only (without the fractions resource kit, and focused on a topic *other than fractions*); and 3) locally chosen "professional development as usual." The study investigated the impact of the three conditions on teachers' and students' knowledge of fractions and on teachers' attitudes toward professional learning.

Teachers' overall *fractions knowledge* was measured using a 33-item scale of items drawn mainly from established assessments.[ii] The pre- to post- scores on this scale for the lesson study with resource kit group compared to the other two study groups are shown in Figure 1 (as Z-scores, per requirements of item use). We examined the impact of the random study assignment through the use of two-level hierarchical linear modeling (HLM), which adjusts for the nesting of teacher participants (Level 1) within lesson study groups (Level 2). Controlling for other Level 1 predictors (e.g., teachers' knowledge of fractions at pretest), we found a statistically significant positive effect of assignment to Condition 1 (lesson study with the fractions resource kit) on the main measure of teachers' *fractions knowledge*. The effect size for this analysis was .18.

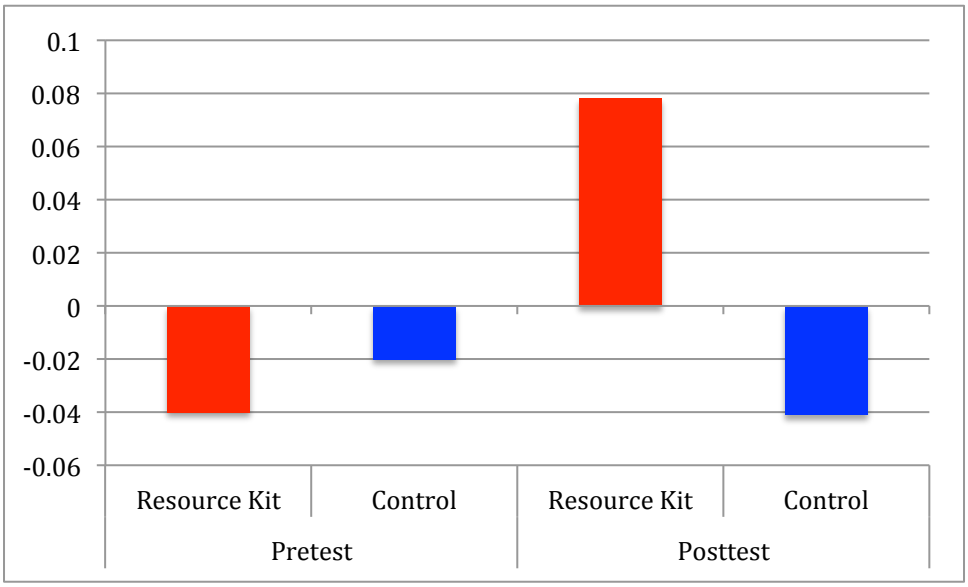

Figure 1. Teachers' Fractions Knowledge (Z Score)

To assess students' fraction knowledge, three different student assessment forms were developed for students in grades 2/3, grade 4, and grade 5, with the lower grade assessments containing a subset of the items included for higher grades.[iii]

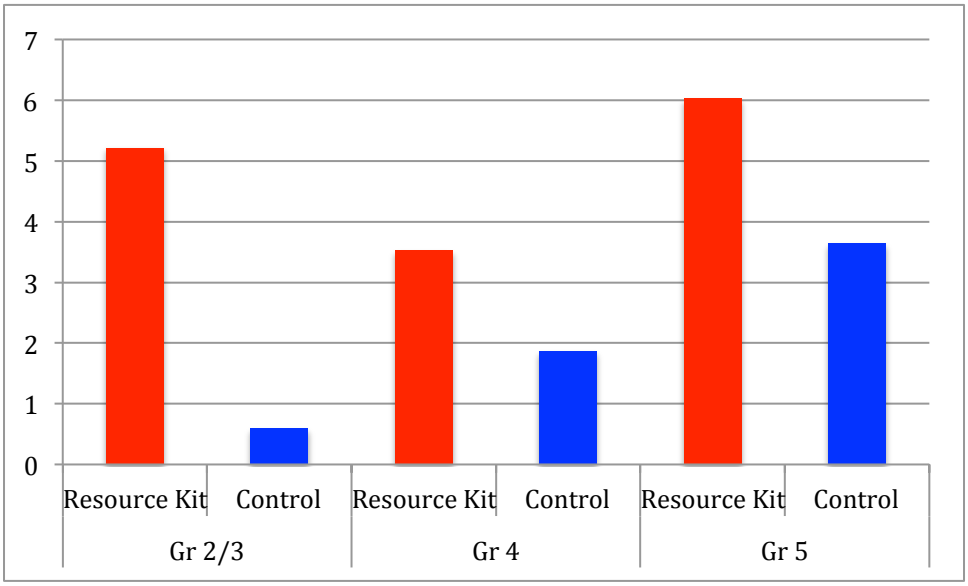

Figure 2. Absolute Score Changes in Students' Knowledge of Fractions

We again used HLM analysis to examine the impact of the random study assignment on students' fractions knowledge. A three-level model was used to investigate student outcomes, with students at Level 1, teachers/ classroom at Level 2, and study groups at Level 3. The only Level 1 covariate was student pretest score. At Level 2, we included teacher demographic covariates

(including lesson study experience and math credential). The assignment to condition was included at Level 3.

The HLM analysis shows a statistically significant positive impact of group assignment to Condition 1 (lesson study with fractions resource kit) on students' *fractions knowledge*. The effect size for this analysis is .50. In addition, we were concerned that some item formats might be more familiar to the students in the experimental group since their teachers might have seen these formats in the resource kit and used them in the classroom. In order to check on the impact of item format, we created two subscales by dividing the total pool of student assessment items into two categories – items with *familiar* and *unfamiliar* formats. The significant positive effect of assignment to Condition 1 held for both the *familiar* and *unfamiliar* item subscales. Although the effect size for the *unfamiliar* item subscale (.53) was somewhat higher than for the *familiar* item subscale (.45), both were substantial, indicating that the intervention impacts fractions knowledge as typically measured in the U.S., as well as measured in ways emphasized in the resource kit (e.g., linear representations, number lines, large fractions as iterations of unit fractions).

Along with knowledge development, the study investigated whether teachers' assignment to the three professional learning conditions influenced their beliefs and dispositions related to instructional improvement. HLM results showed a positive impact of assignment to lesson study with resource kit on teachers' reports of *collegial learning effectiveness,* their *expectations for student achievement*, and the perceived *relevance of research for practice*. Effect sizes for these measures are significantly lower than for the teacher knowledge measures, ranging from -.01 to .05. A marginal positive effect ($p < .10$) was also found for the *using and promoting student thinking* measure. Teachers in the two lesson study conditions rated the impact of their Fall 2009 professional learning experiences significantly more favorably on a variety of indicators of impact (such as intellectual rigor and application to the classroom) than did teachers assigned to professional development as usual.

Analyses are ongoing, so readers are encouraged to check back to www.lessonresearch.net.

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[ii] Including the Learning Mathematics for Teaching project (University of Michigan, Deborah Ball & Hyman Bass, PIs, (Hill, 2010; Hill, Rowan, & Ball, 2005; Hill, Schilling, & Ball, 2004); the Diagnostic Teacher Assessments in Math and Science surveys (University of Louisville, William Bush, PI, Center for Research in Mathematics and Science Teacher Development, 2005); the New Zealand Numeracy Development Projects (Ward & Thomas, 2009), and mathematics research literature (Beckmann, 2005;

Newton, 2008; Norton & McCloskey, 2008; Post, Harel, Behr, & Lesh, 1988; Schifter, 1998; Zhou, Peverly, & Xin, 2006).

[iii] Student assessment items were drawn from established assessments, published research studies, and curriculum materials. The grade 2/3 assessment included 17 items, the grade 4 assessment included 29 items and the grade 5 assessment included 41 items. Of the 5th grade questions, 17 were drawn from foreign curriculum materials (teachers' manuals and student materials, Hironaka & Sugiyama, 2006), 16 were drawn from or were adaptations of problems from the mathematics research literature on fractions (Hackenberg, Norton, Wilkins, & Steffe, 2009; Saxe, 2007; Van de Walle, 2007), and the remaining 8 were drawn from the National Assessment of Educational Progress (Institute of Education Sciences/National Center for Education Statistics (IES/NCES), 2007) and the California Standards Test (California Department of Education, 2005).