Primarily Math

Ruth Heaton, Traci Kutaka & Wendy Smith
University of Nebraska-Lincoln

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Overview of Today’s Session

• Overview of Primarily Math program and research findings (45 minutes)
  – Connecting coursework and classroom video to changes in teacher practices
  – Examining the teacher
  – Connecting teacher data to student math achievement

• Teacher and Principal Panel (45 minutes)
NebraskaMATH

- Targeted Math Science Partnership grant ($9.2 million, 2009-2014) from the National Science Foundation
- Built on previous Math Science Partnership Institute for middle level mathematics teachers (Math in the Middle, 2004-2011)
- Included programs for K-3 and secondary teachers
- Goal: create statewide K-16 partnership to improve mathematics achievement in Nebraska
Philosophy of Change

• Change is slow & difficult (Guskey, 2002)
• Beliefs & practice change in related but non-linear manners (Fullan, 2001)
• Cycles of inquiry & ongoing learning/reflection are critical (Cochran-Smith & Lytle, 2009)
• Teachers as continual learners in, of & from practice (Lampert, 2010)
Primarily Math

- Elementary Mathematics Specialist program
- K-3 teachers
- 18 graduate credit hour program (6 courses)
  - 3 math courses
  - 3 pedagogy/child development courses
- Summer – Academic Year – Summer
- Optional 7th course: leadership
Primarily Math Courses

• Six courses
  – Summer 1: Number & Operations, Parts I & II
  – Fall: Teaching Math K-3: Planning Lessons for Diverse Learners
  – Spring: Helping Young Children Become Mathematical Thinkers
  – Summer 2: Geometry & Algebraic Thinking; Communities of Practice and Mathematics

• Summer courses are week-long, 8:00am-5:00pm with daily 3-4 hours of homework and take-home final (16-20 hours of work)

• AY courses are blended in-person (2-3 days) and online
Primarily Math Classes

Math Classes

• Active learning (small group work, participant presentations, whole group discussion)

• Daily mathematics problem sets with problems ranging from easy to very complicated “habits of mind” problems which had multiple solution paths and often multiple solutions.

• The end-of-course problem set included more problems that require teachers to return to earlier course problems to improve on their solutions, and reflect on their learning.
Sample Math Class Problem

Suppose Laura is a student in your classroom and declares that she has made the following discovery:

As the perimeter of a rectangle increases, so does the area.

Do you agree? Either verify or disprove Laura’s assertion and describe how you might respond to Laura.
Primarily Math Classes

Pedagogy/Child Development Classes

• Major Assignments include
  – Cycles of lesson/unit planning
  – Reflect on videotaped lessons
  – Family projects (2)
  – Child Study
  – Talk Moves
  – Leadership Plan

• Other assignments include scholarly readings & professional writings; online discussion board posting
Primarily Math Teacher Data

• **Mathematical Knowledge for Teaching**
  – Analyze and understand student thinking
  – MKT scores predict student gain scores; relate to mathematics instruction (Hill, 2013)

• **Attitudes Toward Learning Mathematics**
  – Math anxiety is “contagious” (Beilock et al, 2010)
  – Relate to mathematics instruction

• **Beliefs about Mathematics Teaching**
  – Shape teachers’ expectations for students
  – Relate to teaching practices
  – Intense field experience & reflection change beliefs
Primarily Math Data

- Teacher participant & comparison group data include annual
  - Mathematical Knowledge for Teaching
  - Attitudes toward & Beliefs about math teaching & learning
- Participant data include graduate coursework & classroom video
- Student data (subset of classrooms) include math achievement
- Core partner elementary schools participated in social network measure 3x across 5 years
Research Question & Methods

• During and following participation in an elementary mathematics specialist program, what changes were observed in teachers’ mathematical teaching practices?

• Requested 2 videotaped lessons per semester
  – Spring prior to beginning
  – Academic year during Primarily Math
  – During semesters when students were assessed

• Few participants submitted all requested videos but most submitted some

• Collected & analyzed teacher coursework (major assignments)
Methods, ctd.

• MQI Lite (Hill et al., 2010)
• Coded 112 videos from 26 teachers
• Closely examined 26 teachers from the first three cohorts who had submitted multiple annual videos
• Analyzed all major coursework from 9 teachers from cohort 1
• Intersection of coursework & close video analysis = 5 teachers
Findings: Reflections

Teacher assignments revealed change related to:

• Asking questions & keeping lesson objectives in focus;
• Valuing shared ownership of learning;
• Intentionally planning for increased student responsibility;
• Supporting students’ meaning making & establishing mathematical connections;
• Using knowledge of student understanding to inform teaching; and
• Applying knowledge of NCTM process standards & CCSS standards for mathematical practice.
Findings: Videos

• Change was most visible across
  – Richness of Mathematics
  – Errors & Imprecision
  – Student Participation in Meaning-Making & Reasoning

• Change was less visible across
  – Classroom Work is Connected to Mathematics
  – Working With Students & Mathematics

• Teachers with highest overall ratings were high in Student Participation in Meaning-Making & Reasoning
Findings: Videos

• Richness of Mathematics
  – Seemed to be generative for change in instruction
  – Was low for overall low-rated lessons
  – Increased for teachers over time when their overall ratings also increased over time

• Errors & Imprecisions
  – Frequently increased over time
  – Possibly increase is due to increase in mathematical discourse and teacher attempting to have students explain reasoning more often
Implications

• Teachers did gain mathematical knowledge for teaching through Primarily Math courses

• Findings imply foci for support as teachers translate professional development into practices
  – PD like Primarily Math can help increase Richness of Math and focus on Reasoning & Sense-Making
  – Teachers need more support related to Errors & Imprecision
Research Questions

• How did teachers’ knowledge for teaching, attitudes, and beliefs change after participating in Primarily Math?

• Two sets of analyses:
  – Within-cohort change
  – Between-group change (PM vs control)
Methods

• Participants
  – 218 K-3 teachers: 126 Primarily Math teachers (3 cohorts), 92 non-participating teachers
  – Matching at building-level characteristics

• Measurements
  – Mathematical Content Knowledge for Teaching Survey (MKT; Hill et al., 2004)
  – Fennema-Sherman Mathematics Attitudes Scales (Fennema & Sherman, 1976)
  – Mathematics Beliefs Scales (Fennema, Carpenter, & Loef, 1990; Caprano, 2001)
Results: Within-cohort Change

Mathematical Content Knowledge for Teaching:
Results: Within-cohort Change

Attitudes toward Mathematics Learning:
Results: Within-cohort Change

Beliefs about Mathematics Teaching:

![Graph showing changes in beliefs over time]
Results: Between-group Change

Mathematical Content Knowledge for Teaching:
Results: Between-group Change

Attitudes toward Mathematics Learning:

![Graph showing anxiety ratings for different cohorts over time.](image-url)
Results: Between-group Change

Beliefs about Mathematics Teaching:

![Graph showing changes in student-centered beliefs rating over time for different cohorts.](image-url)
Discussion: Teacher Change

• **Why did teachers change?**
  – Content of the courses
  – Sequence of the courses
  – Structure of the courses

• **Holistic approach**
  – Primarily Math program is more than the sum of individual parts
  – Content, sequence, and structure of the coursework are collectively responsible for teacher changes
  – Community of teachers
Limitations

• Composition of comparison group
• Self-selection
• Attrition
• Matching at building level
Student Achievement

• Description of the Problem
  – Significance of mathematical thinking and reasoning in the early years
    • Low proficiency scores in TIMSS and PISA
    • Achievement gap based on SES

• Nature of the Problem
  – Teacher preparedness to teach

• Extent of the Problem
  – Limited studies that demonstrate causal effect of teacher professional development on student learning and/or achievement
Research Questions

• To what extent do the students in the classrooms of Primarily Math teachers differ in their mathematics achievement relative to the students of teachers in a matched comparison group?

• Do other variables, such as SES, time spent in study, and measures of teacher knowledge, attitudes, and beliefs have an impact on student mathematics achievement?
Method

• Analyzed Sample
  – Cohorts 1-3

• Predictors
  – Teacher-level predictors
    • Mathematical Content Knowledge for Teaching
    • Attitudes towards Learning Mathematics
    • Beliefs about Teaching Mathematics and Student Learning
  – Socio-Economic Status

• Student-Level Outcomes
  – Change from fall to spring in Math Ability Scores
    (as measured by the TEMA-3)
Analytical Approach

**Observed and Predicted Mean \( \textit{MASD} \)**

![Graph showing observed and predicted mean MASD over years of study. The graph displays a linear trend with observed data scattered around a central line and predicted data also following a trend, with some overlap.](image-url)
Observed Changes in Math Ability Scores (MASD) by Academic Year

Year in Study

MASD

-20 -10 0 10 20 30 40
1 2 3 4
Differential Impact on Student Achievement

- Graph of 2012/13 TEMA-3 scores of students in Primarily Math classrooms
- While all groups of students gained from fall to spring, students who started below average gained the most

<table>
<thead>
<tr>
<th>PM Teachers</th>
<th>Above Average</th>
<th>Average</th>
<th>Below Average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fall</td>
<td>Spring</td>
<td>Fall</td>
</tr>
<tr>
<td>Median score</td>
<td>117</td>
<td>127</td>
<td>99</td>
</tr>
<tr>
<td>Number</td>
<td>50</td>
<td>50</td>
<td>176</td>
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</table>
Interpretation of Findings

- Students in Primarily Math classrooms demonstrated larger than expected growth
  - Initial differences in student growth fall to spring
  - Within classroom variability very large

- Spring variability < Fall variability

- Growth in scores from fall to spring
Principal and Teacher Panel

- **Sue Braun**, Principal, Kloefkorn Elementary, Lincoln Public Schools
- **Danielle Dudo**, 2nd grade, Newell Elementary, Grand Island Public Schools
- **Jennifer Kaminski**, 3rd grade, Benson West Elementary, Omaha Public Schools
- **Kristine Ray**, kindergarten, West Lincoln Elementary, Lincoln Public Schools
Sustaining Our Efforts

• While NSF funding is ended, opportunities remain to bring Primarily Math to local districts and ESUs

• How can you bring Primarily Math to your area?
  – OPS model: find a private foundation willing to underwrite all costs (The Sherwood Foundation®, Lozier Foundation)
  – LPS model: use Title I Professional Development funds to underwrite all costs for teachers in Title I buildings
  – ESU 3 model: districts use professional development funds to partially or fully underwrite tuition/fee costs
  – ESU 5 model: Beatrice used Title I Professional Development funds to underwrite tuition costs of one course
  – University of Nebraska Foundation continues to raise funds from private sources to provide tuition fellowships to teachers

• Contact nebraskamath@unl.edu for more information
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