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NebraskaMATH: Sharing Findings from a Statewide Partnership

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Abstract for DBER Group Discussion on 2015-09-17

Presenter(s), Department(s):
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University of Nebraska-Lincoln

Title:
NebraskaMATH: Sharing Findings from a Statewide Partnership

Abstract:
I will share findings from the NebraskaMATH statewide partnership, which was funded by the NSF for $9.2 million, 2009-2014. This large Math Science Partnership project included professional development and research components that targeted K-3 (Primarily Math), algebra (Nebraska Algebra) and novice secondary teachers (New Teacher Network). The Primarily Math program was the main focus of the research, and I will share findings of teacher change and the associated student achievement gains. Overall, teachers who participated in Primarily Math gained in their mathematical knowledge for teaching, their attitudes toward mathematics, and their student-centered beliefs, while seeing decreases in their mathematical anxiety. Students in classrooms with Primarily Math teachers had greater fall-spring math achievement gains than did students in comparison classrooms. I will also discuss current and future directions of the statewide partnership.
Understanding the Impact of Professional Development on Mathematics Teaching and Learning for K-3 In-service Teachers

Wendy M. Smith, University of Nebraska-Lincoln

Presentation to the DBER Seminar
September 17, 2015
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, $5 million)
- Included programs for K-3 and secondary teachers
- Goal: create statewide K-16 partnership to improve mathematics achievement in Nebraska
NebraskaMATH

- Primarily Math: K-3 Mathematics Specialists (18 cr hrs)
- Math in the Middle: 4th-8th master of arts for teachers (36 cr hrs)
- Nebraska Algebra: secondary algebra teachers (9 cr hrs)
- New Teacher Network: novice secondary teachers (0-3 years of experience) (18-24 cr hrs)
- Nebraska Math and Science Summer Institutes: graduate courses offered statewide each summer
Statewide Partnership

KEY:

- Primarily Math
- Nebraska Algebra
- New Teacher Network

Out of state or not teaching
Teaching college level
Retired

Math in the Middle
2011-2012 Teaching Positions
Noyce Master Teaching Fellows
Philosophy of Change

• Teachers need to deepen their Mathematical Knowledge for Teaching (CBMS, 2012)
• 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)
Literature Review

- **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 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
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)
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
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
Research Question, Part 2

• 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)
## Timeline of the Study

<table>
<thead>
<tr>
<th>Year</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
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<tbody>
<tr>
<td><strong>Cohort 1 (n = 34):</strong></td>
<td></td>
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<tr>
<td>Pretest</td>
<td>Posttest</td>
<td>Follow-up 1</td>
<td>Follow-up 2</td>
<td>Follow-up 3</td>
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<tr>
<td><strong>Cohort 2 (n = 25):</strong></td>
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<tr>
<td>Baseline</td>
<td>Pretest</td>
<td>Posttest</td>
<td>Follow-up 1</td>
<td>Follow-up 2</td>
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<td><strong>Cohort 3 (n = 67):</strong></td>
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<tr>
<td>Baseline</td>
<td>Baseline</td>
<td>Pretest</td>
<td>Posttest</td>
<td>Follow-up 1</td>
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<td><strong>Comparison (n = 92):</strong></td>
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<td>Occasion 1</td>
<td>Occasion 2</td>
<td>Occasion 3</td>
<td>Occasion 4</td>
<td>Occasion 5</td>
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</table>
Results: Within-cohort Change

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

Attitudes toward Mathematics Learning:

![Graph showing changes in attitudes towards mathematics learning over time. The graph indicates trends in confidence, effectance-motivation, and anxiety with data points for pretest, posttest, follow-up 1, follow-up 2, and follow-up 3.]
Results: Within-cohort Change

Beliefs about Mathematics Teaching:

<table>
<thead>
<tr>
<th></th>
<th>Pretest</th>
<th>Posttest</th>
<th>Follow-Up 1</th>
<th>Follow-Up 2</th>
<th>Follow-Up 3</th>
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</thead>
<tbody>
<tr>
<td>Student-centered Beliefs</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Teacher-centered Beliefs</td>
<td></td>
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</tbody>
</table>

Cohort 1 Teacher Beliefs Rating
Results: Between-group Change

Mathematical Content Knowledge for Teaching:

![Graph showing changes in mathematical content knowledge for teaching across different cohorts and time points.](image-url)
Results: Between-group Change

Attitudes toward Mathematics Learning:
Results: Between-group Change

Beliefs about Mathematics Teaching:

Student-Centered Beliefs Rating

- Cohort 1
- Cohort 2
- Cohort 3
- Comparison

Baseline | Baseline | Pretest | Posttest | Follow-up 1 | Follow-up 2 | Follow-up 3
Discussion

• 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
Research Questions, Part 3

• 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: Hierarchical Linear Modeling

\[ \text{MASD}_{ijk} = \beta_{00k} + \beta_{01k} \text{Time}_{jk} + \beta_{02k} \text{FMA}_{ijk} + \beta_{03k} \text{SES}_{jk} + \sum \beta_{0qk} X_{jk} \]

\begin{align*}
\beta_{00k} &= \gamma_{000} + \gamma_{001} \text{Treatment}_k + u_{00k} \\
\beta_{01k} &= \gamma_{010} + \gamma_{011} \text{Treatment}_k + u_{01k} \\
\beta_{0qk} &= \gamma_{0q0} & (q = 1, 2, \ldots, Q)
\end{align*}
Analytical Approach

Observed and Predicted Mean \( \text{MASD} \)

Year in Study

\( \text{MASD} \)

1 2 3 4

Observed Predicted
Results

Observed and Predicted Mean $MASD$

Control

Treatment
Analytical Approach: Hierarchical Linear Modeling

\[ M_{i,j,k} = \beta_{00k} + \beta_{01k}T_{ime_{j,k}} + \beta_{02k}F_{MAS_{i,j,k}} + \beta_{03k}S_{ES_{j,k}} + \beta_{04k}G_{eom_{j,k}} + \beta_{05k}A_{nxiety_{j,k}} + \beta_{06k}C_{onfidence_{j,k}} + \beta_{07k}T_{belief_{j,k}} + r_{i,j,k} \]

\[ \beta_{00k} = \gamma_{000} + \gamma_{001}T_{reatment_{k}} + u_{00k} \]

\[ \beta_{01k} = \gamma_{010} + u_{01k} \]

\[ \beta_{02k} = \gamma_{020} \]

\[ \vdots \]

\[ \beta_{07k} = \gamma_{070} \]
### Fixed and Random Effects for Final Model

<table>
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<tr>
<th>Fixed Effect</th>
<th>Estimate</th>
<th>SE</th>
<th>Random Effect</th>
<th>Variance</th>
<th>SD</th>
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<td>SES</td>
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<td>Teacher*Time</td>
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<td>Treatment</td>
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<tr>
<td>Confidence</td>
<td>1.25</td>
<td>0.469</td>
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</tbody>
</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
Limitations

- Composition of comparison group
- Self-selection
- Attrition
- Matching at building level
- Video data cannot fit into quantitative models of teacher change
- Ceiling effects (3rd grade)
Statewide Partnerships

- Omaha Public Schools Teacher Leader Academy
  - $5.5m 2013-2016 to continue Primarily Math, Math in the Middle, New Teacher Network with OPS teachers
- UNL-Lincoln Public Schools Title I Professional Development Partnership
  - $1.1m 2014-2015 for LPS Title I K-8 teachers: Primarily Math and Math in the Middle
- Strengthening Mathematics in Nebraska’s Panhandle
  - $125k ITQ grants from Nebraska, for ESU 13 and Scottsbluff (K-8)
- ESU 3: 2014-2015 Primarily Math cohort funded by districts and teachers (and some UNL dollars)
Nebraska Math and Science Summer Institutes

- Graduate courses for K-12 teachers offered at 10-12 locations statewide each summer
- Has comprised as much as 25% of all graduate credit hours in the summer at UNL
- Some districts can provide full/partial tuition fellowships

NMSSI Course Locations
2008 through 2014

- Districts/ESUs can request particular courses to meet their teachers’ needs
- We often employ master teachers to teach these courses
Future Directions

• WIN grant for 2016 (Primarily Math)
• ITEAM (18 cr hr program for Intermediate Teachers of Math, grades 4-6)
• Grow the NMSSI
• Help leverage current partnership to build a statewide science partnership
• Continue to pursue grants and other external funding to provide support for teachers to take graduate courses, and to fund research into these activities
With thanks to the NebraskaMATH research team

- Other UNL faculty: Michelle Homp, Tony Albano, Roger Bruning, Doug Kauffman
- Our evaluator: RMC Research; team led by John Sutton
- Grad students past (current location) and present:
  - Traci Kutaka (SRI International), Lixin Ren (UNL), Heidi Beattie (Troy U), Jenny Green (Montana St U), Mary Alice Carlson (Montana St U), Yinjing Shen (U Texas), Elizabeth Petit Cunningham (U Michigan-Flint), Pam Fellers (Grinnell U), Kelly Grinnell (ESU2), Molly Williams, Chansuk Kang
- Countless K-12 teachers who have graciously participated in the research projects and helped us to collect data.

*now retired
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