The Relation between Teacher-Related Factors and Student Mathematics Achievement

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• Knowledge and beliefs of teachers matter (Pajares, 1992; Philipp, 2007)

• No studies identified to date have examined the collective effects of beliefs and knowledge on students’ mathematics achievement (Ekmekci, Corkin, & Papakonstantinou, 2015)
Self-efficacy Beliefs

• Built on Bandura’s (1986) self-efficacy framework
• Defined as the extent to which teachers believe they can successfully enact teaching-related tasks. (Tschannen-Moran & Hoy, 2001)
• Linked to instructional approaches, students’ motivation and achievement. (e.g., Stipek et al., 2001)
Outcome Expectancy

• Defined as how much teachers attribute student outcomes (i.e., achievement) to themselves or external factors. (Rose & Medway, 1981)

• Positively predicts teacher job performance and student achievement. (Jeloudar & Lotfi-Goodarzi, 2012; Rose & Medway, 1981)
Epistemic Beliefs

• Defined as an individual’s belief about knowledge. Where does it come from? What is the essence of it? How does one come to know and justify beliefs? (Hofer & Pintrich, 1997)

• Conceptualized on a continuum from non-availing to availing. (Muis, 2004)

• Found to be associated with teaching practices. (Gill et al., 2004)
Math Knowledge for Teaching

• Defined as
  “The mathematical knowledge that teachers use in classrooms to produce instruction and student growth” (Hill, Ball, & Schilling, 2008, p. 374).

• Found to be associated with student performance (Hill, Rowan, & Ball, 2005)
Other Factors

- Experience (Rice, 2003)
- Educational background in subject matter (Rice, 2003)
A. To what extent do students’ demographic characteristics and prior math achievement relate to their subsequent math achievement?

B. To what extent do teacher-level characteristics (e.g., beliefs, MKT, college math degree, and experience) relate to students’ math achievement?

C. To what extent does the relation between student level factors and math achievement vary by teacher-level characteristics?
Conceptual Map

Student-level Variable
- Math Performance (Previous Year)
- Gender
- Race/ethnicity
- Free/reduced lunch

Teacher-level Variables
- Teaching Experience
- Math Degree
- MKT
- Self-efficacy
- Outcome Expectancy
- Epistemic Beliefs

Students’ Mathematics Performance

A

B

C
Surveys and Data

• Teacher data:
  – Survey:
    • Demographics and teachers’ educational background
    • Teacher self-efficacy (Enochs, Smith, & Huinker, 2000)
    • Outcome expectancy (Enochs, Smith, & Huinker, 2000)
    • Epistemic beliefs (Schoenfeld, 1989)
  – MKT:
    • Learning Mathematics for Teaching (LMT) assessment
      (Hill, Schilling, & Ball, 2004)

• Student data (HERC):
  – Student NCE scores on Stanford 10-Math
This study included 34 K-8 mathematics teachers and their 2230 students.

**School Level of Teachers**
- 33% Elementary (K-5)
- 67% Middle School (6-8)

**Gender of Teachers**
- 77% Female
- 23% Male
### Results

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Model 1 (unconditional)</th>
<th>Model 2 (within teacher)</th>
<th>Model 3 (between teacher)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fixed Effects</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>55.61** (1.91)</td>
<td>56.5** (1.38)</td>
<td></td>
</tr>
<tr>
<td>Prior Math Achievement</td>
<td>16.53** (0.46)</td>
<td>16.63** (0.47)</td>
<td></td>
</tr>
<tr>
<td>Years of Teaching</td>
<td>1.55</td>
<td>1.18</td>
<td></td>
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<tr>
<td>Math Degree</td>
<td>4.04* (1.18)</td>
<td></td>
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<tr>
<td>LMT</td>
<td>7.89** (1.47)</td>
<td></td>
<td></td>
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<tr>
<td>Self-Efficacy</td>
<td>-0.45</td>
<td>1.46</td>
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</tr>
<tr>
<td>Locus of Control</td>
<td>1.23</td>
<td>1.25</td>
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<tr>
<td>Epistemic Beliefs (Non-Availing)</td>
<td>3.29</td>
<td>1.49</td>
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<tr>
<td>Prior Math Achievement X</td>
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<td></td>
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<tr>
<td>Years of Teaching</td>
<td>-0.24</td>
<td>0.43</td>
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<tr>
<td>Math Degree</td>
<td>-0.22</td>
<td>0.46</td>
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<tr>
<td>LMT</td>
<td>0.18</td>
<td>0.53</td>
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<tr>
<td>Self-Efficacy</td>
<td>0.23</td>
<td>0.54</td>
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<tr>
<td>Locus of Control</td>
<td>0.01</td>
<td>0.48</td>
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<tr>
<td>Epistemic Beliefs</td>
<td>0.42</td>
<td>0.54</td>
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</tr>
<tr>
<td><strong>Random Effects (Variance Components)</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Student-level effect $r_{ij}$ ($\sigma^2$)</td>
<td>309.27** (9.33)</td>
<td>109.03** (3.31)</td>
<td>109.01** (3.31)</td>
</tr>
<tr>
<td>Intercept Teacher mean, $u_{ij}$</td>
<td>115.94** (29.73)</td>
<td>119.54** (29.58)</td>
<td>51.21** (13.00)</td>
</tr>
</tbody>
</table>

| Variance explained                        | 27%                     | 65%                      | 57%                       |
| AIC                                       | 19225                   | 16972                    | 16966                     |

* $p < .01$. ** $p < .001$. 

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**Arrow A**

**Arrow B**

**Arrow C**
• Significant stand-alone predictors of mathematics achievement were
  – Prior mathematics achievement \((student\ level)\)
  – Teachers’ mathematics degrees \((teacher\ level)\)
  – Teachers’ MKT \((teacher\ level)\)

• The effects of prior math achievement did not vary significantly across teachers
• Findings may provide practical implications for the School Districts related to the recruitment and professional development of mathematics teachers.

• Follow-up analysis will include examining other student level variables
THANK YOU!

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