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The Collective Effects of Teachers' Educational Beliefs and Mathematical Knowledge on Students' Mathematics Achievement

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Outline

- Introduction
- Background
- Research Questions
- Method
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- Conclusions

Purpose

To investigate the predictive value of
teacher-related factors such as
beliefs, knowledge, and professional background
on student mathematics achievement

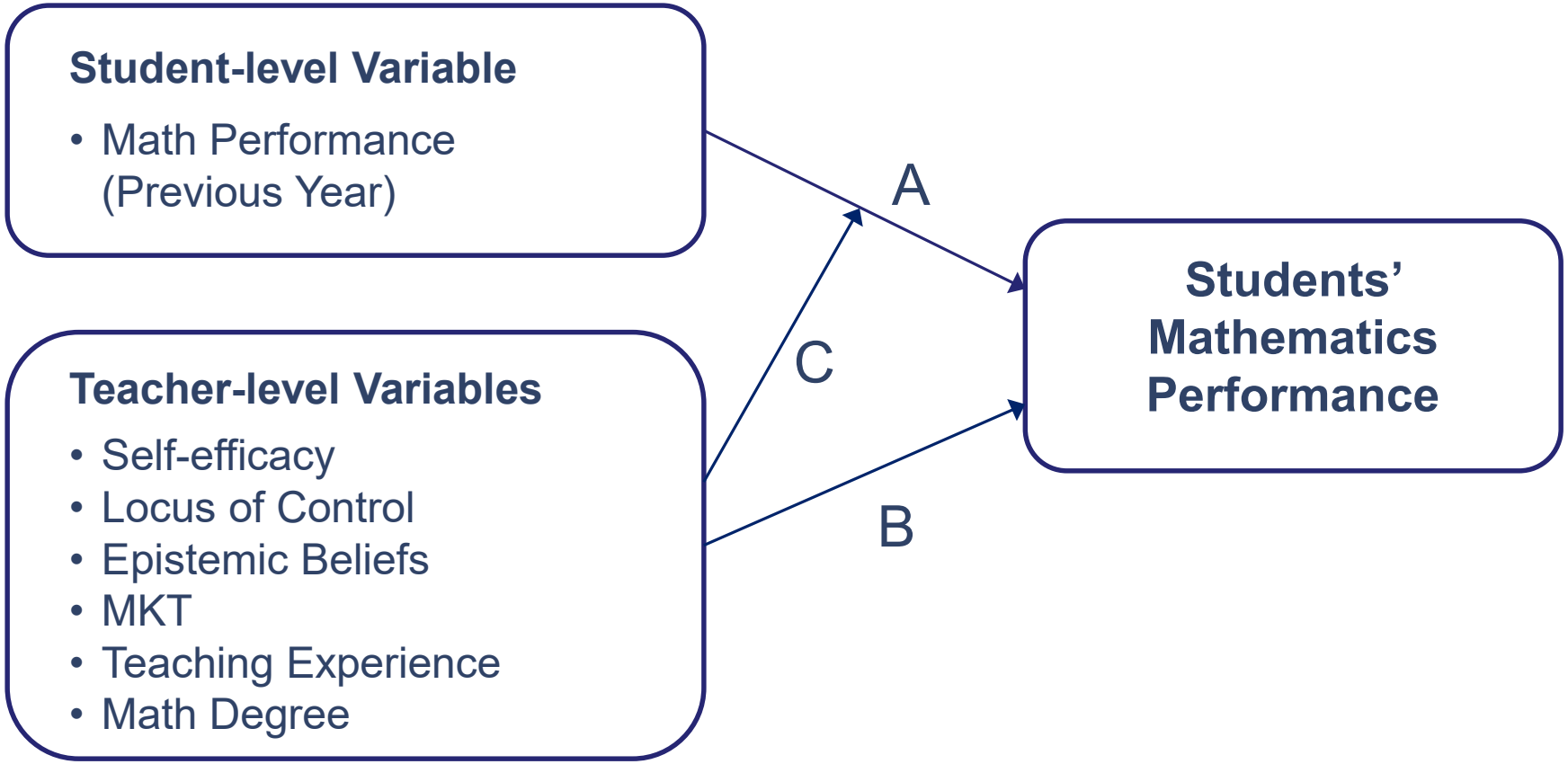
Theory

- Teacher educational beliefs:
  - Self-efficacy beliefs: degree to which teachers believe they can successfully perform teaching-related tasks within a particular domain or context (Enochs, Smith, & Huinker, 2000)
  - Internal locus of control: extent to which teachers attribute student outcomes (i.e., achievement) to themselves or other (external) factors (Rose & Medway,1981)
  - Epistemic beliefs: beliefs about the nature of knowledge—i.e., where it comes from, its essence, and how one comes to know (Hofer & Pintrich, 1997)

Theory (cont.)

- Mathematical Knowledge for Teaching (MKT):
  "The mathematical knowledge that teachers use in classrooms to produce instruction and student growth" (Hill, Ball, & Schilling, 2008, p. 374).
- Experience
  - High experience: 6 years or more
  - Low experience: < 6 years (Wolters & Daugherty, 2007)
- Educational background in subject matter (Rice, 2003)

Conceptual Map



Research Questions

A. To what extent do students' 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 students' prior math achievement and current math achievement vary by teacher-level characteristics?

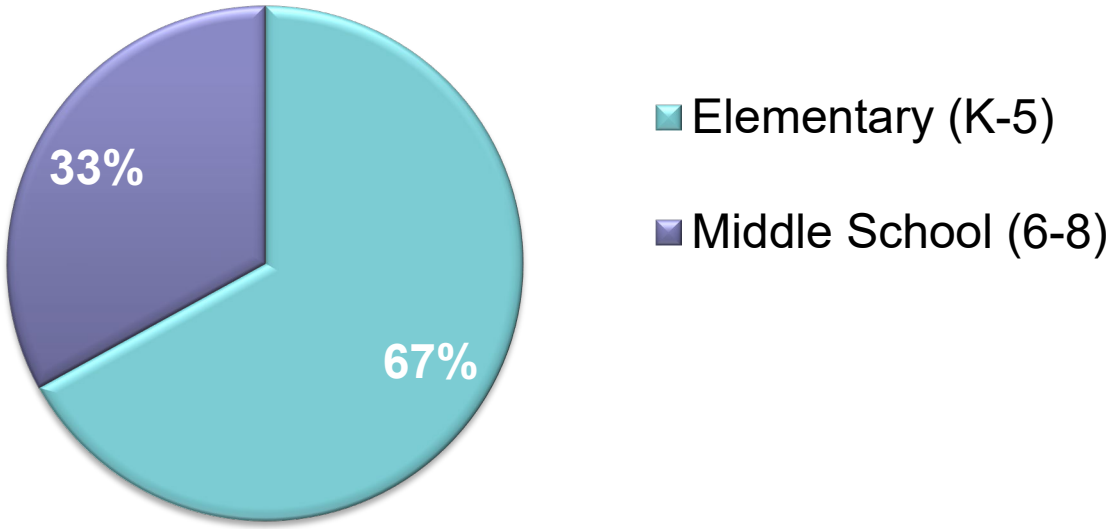
Surveys and Data

- Teacher data:
  - Survey:
    - Demographics and teachers' educational background
    - Teacher self-efficacy (Enochs, Smith, & Huinker, 2000)
    - Internal locus of control (Enochs, Smith, & Huinker, 2000)
    - Epistemic beliefs (Schoenfeld, 1989)
  - MKT:
    - Learning Mathematics for Teaching (LMT) assessment (Hill, Schilling, & Ball, 2004)
- Student data:
  - Student scores on a standardized mathematics test (Stanford 10) given at the end of the academic year

Participants

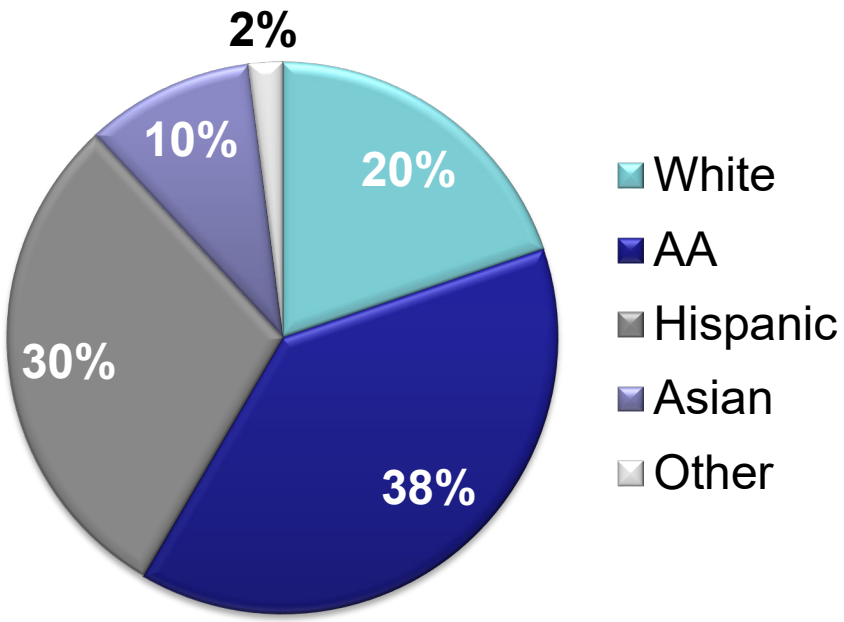
- This study included 39 of 80 K-12 math teachers who participated in a summer professional development (PD) program.

School Level of Teachers Included in the study

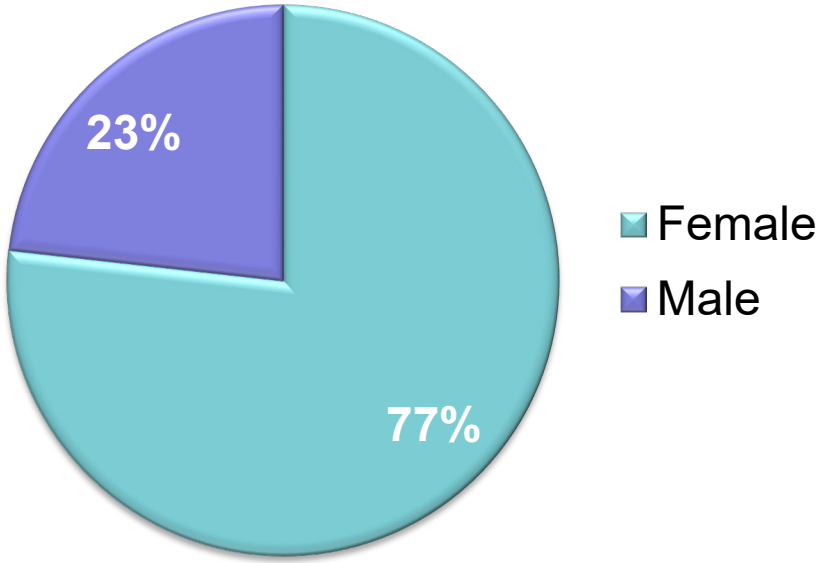


Participants (cont.)

Demographic Breakdown of Participating Teachers

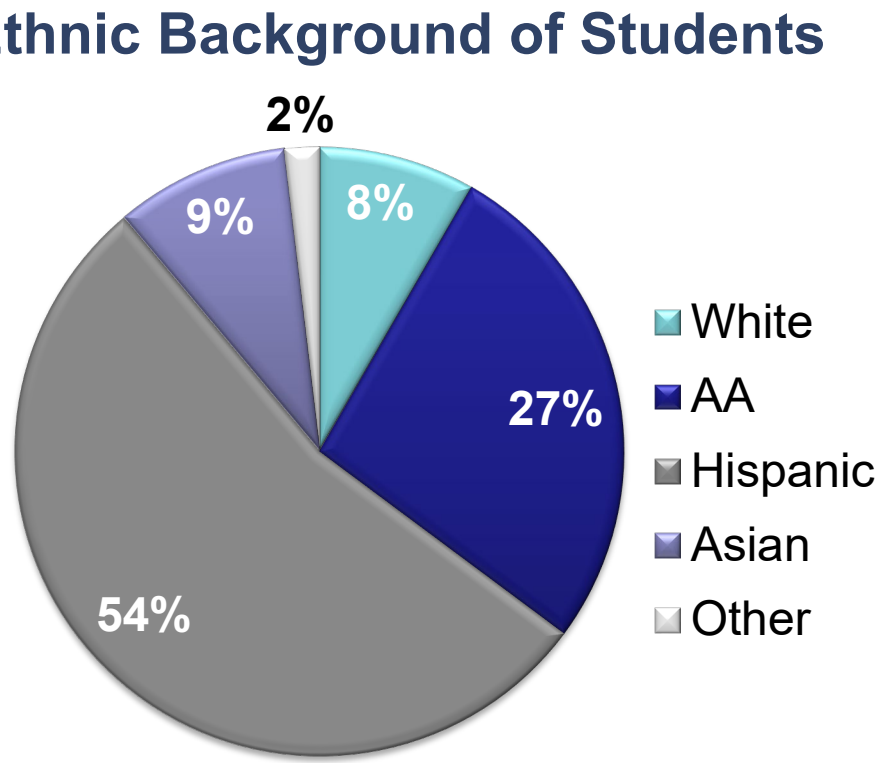


Gender of Participating Teachers



Participants (cont.)

- This study included 2038 K-8 students (List-wise deletion resulted in a sample size of 1129).



Results

Independent Variable	Model 1 (unconditional) β	Model 1 SE	Model 2 (within teacher) β	Model 2 SE	Model 3 (between teacher) β	Model 3 SE
Fixed Effects						
Intercept	0.03	0.10	0.02	0.11	0.21	0.16
Prior Math Achievement			0.79***	0.02	0.85***	0.05
Self-Efficacy					-0.19	0.16
Locus of Control					0.02	0.12
Epistemic Beliefs					0.28	0.16
LMT					0.06	0.15
Math Degree					0.42*	0.19
Years of Teaching					0.09	0.11
Prior Math Achievement X						
Self-Efficacy					-0.02	0.03
Locus of Control					0.02	0.03
Epistemic Beliefs					0.00	0.04
LMT					0.04*	0.03
Math Degree					0.08	0.06
Years of Teaching					0.06*	0.03
Random Effects (Variance Components)						
Student-level effect r_{ij} (σ^2)	0.77***	0.03	0.30***	0.01	0.29***	0.01
Intercept Teacher mean, u_{0j}	0.26**	0.08	0.26**	0.09	0.24*	0.10
Slope, u_{1j} (τ_{11})					0.00	0.01
Wald *Z* (Variance explained)	3.260** (25%)		2.864** (64%)		2.660** (9%)	
AIC / BIC	3775 / 3785		1938 / 1948		1932 / 1942	

* $p < .05$. ** $p < .01$. *** $p < .001$.

Arrow A

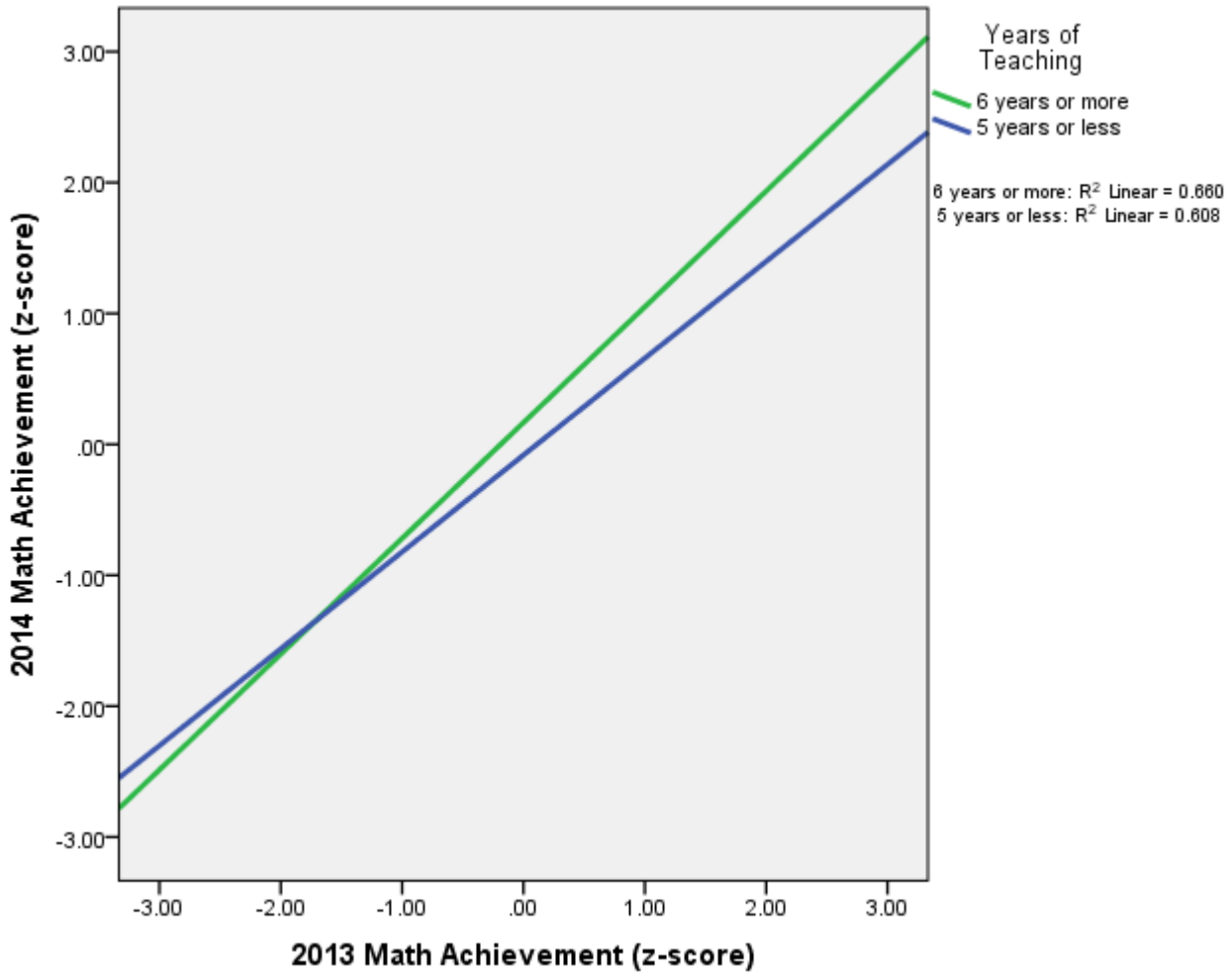
Arrow B

Arrow C

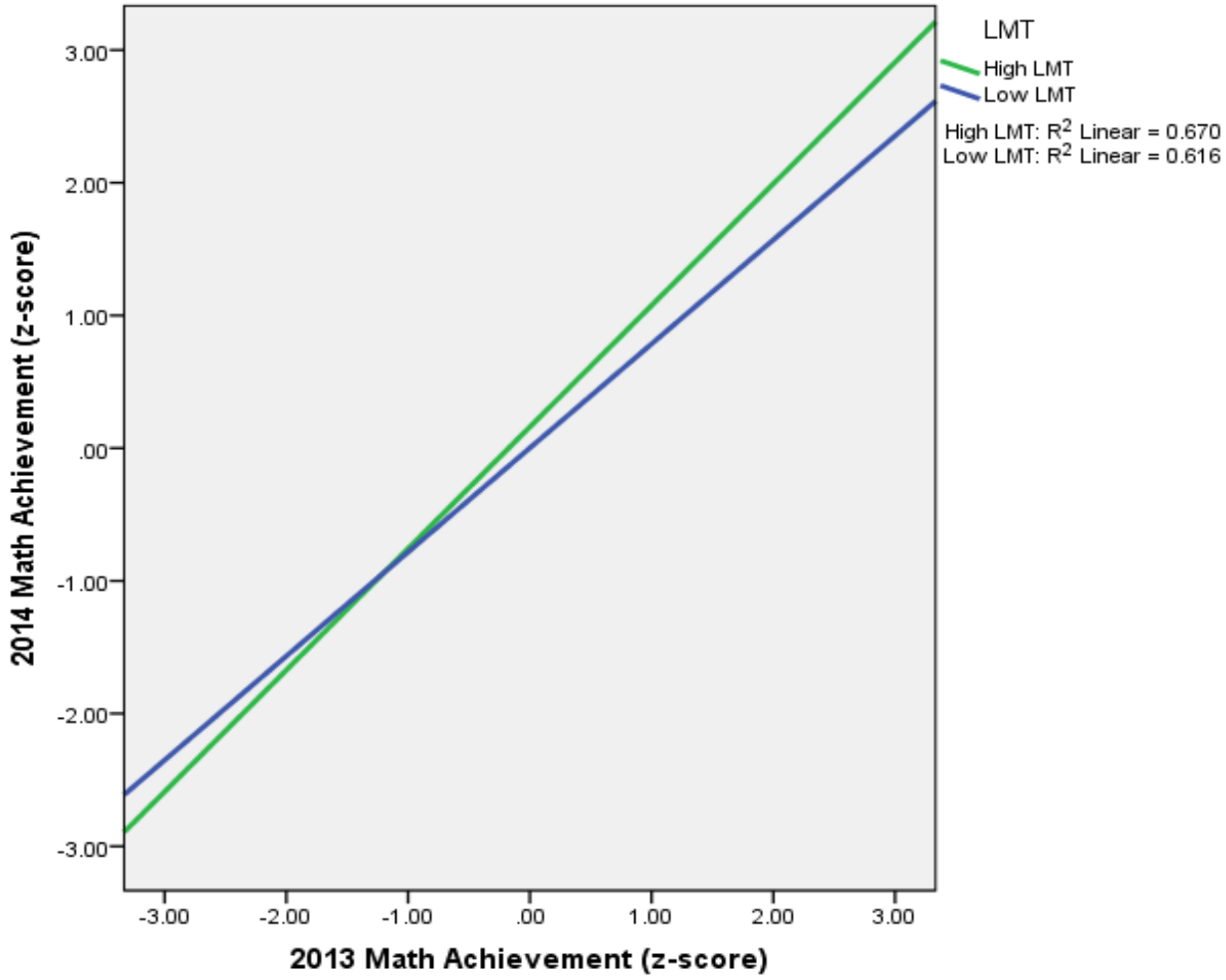
Results

- Significant stand-alone predictors of mathematics achievement were
  - Prior mathematics achievement *(student level)*, and
  - Teachers' mathematics degrees *(teacher level).*
- Teachers' years of experience and MKT had a significant effect on the relation between prior and current mathematics achievement.

Years of Teaching



MKT


LMT
High LMT
Low LMT
High LMT: R2 Linear = 0.670
Low LMT: R2 Linear = 0.616
2014 Math Achievement (z-score)
3.00
2.00
1.00
.00
-1.00
-2.00
-3.00
2013 Math Achievement (z-score)
-3.00
-2.00
-1.00
.00
1.00
2.00
3.00

Conclusions

- Students' prior achievement is the most significant predictor of math achievement (Duncan et al., 2007).
- Teachers having math degrees is positively associated with students' math achievement (Rice, 2003).
- Teaching experience and MKT moderates the relation between prior and current math achievement (Hill, Rowan, & Ball, 2005).
- Teachers' beliefs did not emerge as statistically significant predictors of students' math achievement (see Corkin, Ekmekci, & Papakonstantinou, 2015).

Implications

- Teacher educators should pay close attention to developing MKT.
- Teacher preparation courses should place an emphasis on improving MKT.
- Administrators should retain experienced teachers and provide support for less experienced teachers (e.g., induction, mentoring, collaboration, PD programs).
- Teachers who do not have a strong math background should be given opportunities to learn more math content.

THANK YOU !

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The slides will be available at RUSMP website