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RUSMP's Research and Evaluation of the Summer Campus Program (SCP)

Danya Corkin & Adem Ekmekci
Rice University

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Agenda

- RUSMP's Research and Evaluation
  - Goals
  - SCP overview
  - Data collection process
  - Survey constructs
- Study: *The collective effects of teachers' educational beliefs and mathematical knowledge on students' mathematics achievement*
- Studies in progress
- Completed papers

Goals

- To investigate the impact of RUSMP's SCP on K-12 mathematics teachers':
  - motivational beliefs about math and teaching math,
  - content and pedagogical knowledge, and
  - technology beliefs, knowledge, and usage;
- To investigate the relations among the above factors
- To investigate the effect of teachers' beliefs and knowledge on students' mathematics achievement.
- To investigate the effect of the school work-environment on teachers' motivation.

Program Overview

- 80 K-12 math teachers in the greater-Houston area
  - mostly from Houston ISD
- 4 classes: elementary (K-3), intermediate (4-6), middles school (7-8), and high school (9-12)
- 3-week summer program
- 6 academic-year follow-up meetings

Program Overview (cont.)

- 2013 & 2015 content focus:

  (a) numbers, operations, and quantitative reasoning
  (b) patterns, relations, and algebraic reasoning

- 2014 & 2016 content focus:

  (a) geometry, spatial sense, and measurement

  (b) data analysis, statistics, and probability

Data Collection

- Survey
  - Pre-survey: 4-5 weeks before SCP (May)
  - Post-survey: at the end of SCP (June)
  - Follow-up-survey: after academic-year meetings (March)
- Content assessment (RUSMP)
  - Pre-assessment: 2-3 weeks before SCP (May)
  - Post-assessment: at the end of SCP (June)
- Standardized assessment (DTAMS/LMT)
  - Pre-assessment: 2-3 weeks before SCP (May)
  - Delayed-post-assessment: at the last academic year meeting (February)

Data Collection (cont.)

- Student achievement data
  - Standardized achievement data (previous and current year)
  - Obtained through
    - School districts
    - Houston Education Research Consortium (HERC)

Survey Data

- Demographics
  - Age
  - Gender
  - Race/Ethnicity
- Educational Background
  - Grade level and content areas taught
  - University math background
  - Teaching preparation
  - Teaching certification
  - Years of teaching

Survey Constructs

- Motivational Beliefs
  - Math teaching self-efficacy (Enochs et al., 2000)
  - Teaching self-efficacy (Klassen et al., 2009)
  - Intrinsic value for teaching (Linnenbrink-Garcia et al., 2010)
  - Grit (Duckworth et al., 2007)
  - Math self-concept (Marsh, 1990)
  - Epistemic beliefs about mathematics (Hofer, 2000)
  - Standards-based math teaching (Ross et al., 2003)

Survey Constructs (cont.)

- Technology
  - Technological pedagogical content knowledge (Schmidt et al., 2009)
  - Technology integration self-efficacy (Wang, Ertmer, & Newby, 2004)
  - Frequency of technology use (RUSMP)
- School-Work Climate
  - Principal autonomy support (Baard, Deci, & Ryan, 2000)
  - Perceived person-organization fit (Pogodzinski, Youngs, & Frank, 2013)
  - Perceptions about large-scale assessments (Brown, 2004)

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

Outline

- Introduction
- Background
- Research Questions
- Method
- Results
- Conclusions

Purpose

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

Outline of Background

- Three types of educational beliefs:
  - Self-efficacy beliefs
  - Internal locus of control
  - Epistemic beliefs
- Definition
- Outcomes
- Antecedents

Self-efficacy Beliefs

- Defined as the extent to which teachers believe they can successfully execute teaching-related tasks. (Tschannen-Moran & Hoy, 2001)
- Linked to instructional approaches, students' motivation and achievement. (Stipek et al., 2001)
- Four sources (Bandura, 1986):
  1. personal mastery experiences
  2. vicarious experiences (observation of models)
  3. affective indicators
  4. social persuasion

Internal Locus of Control

- 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)
- Examined in teacher efficacy research using the same antecedents as those for self-efficacy. (Swackhamer, Koellner, Basile, & Kimbrough, 2009)

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)

knowledge is fixed, simple, certain, objective, comes from an authority

knowledge is evolving, complex, uncertain, subjective, stems from one's own construction of knowledge

Epistemic Beliefs (cont.)

- Higher levels of education are associated with more availing epistemic beliefs.
  (King, Wood, & Mines, 1990)

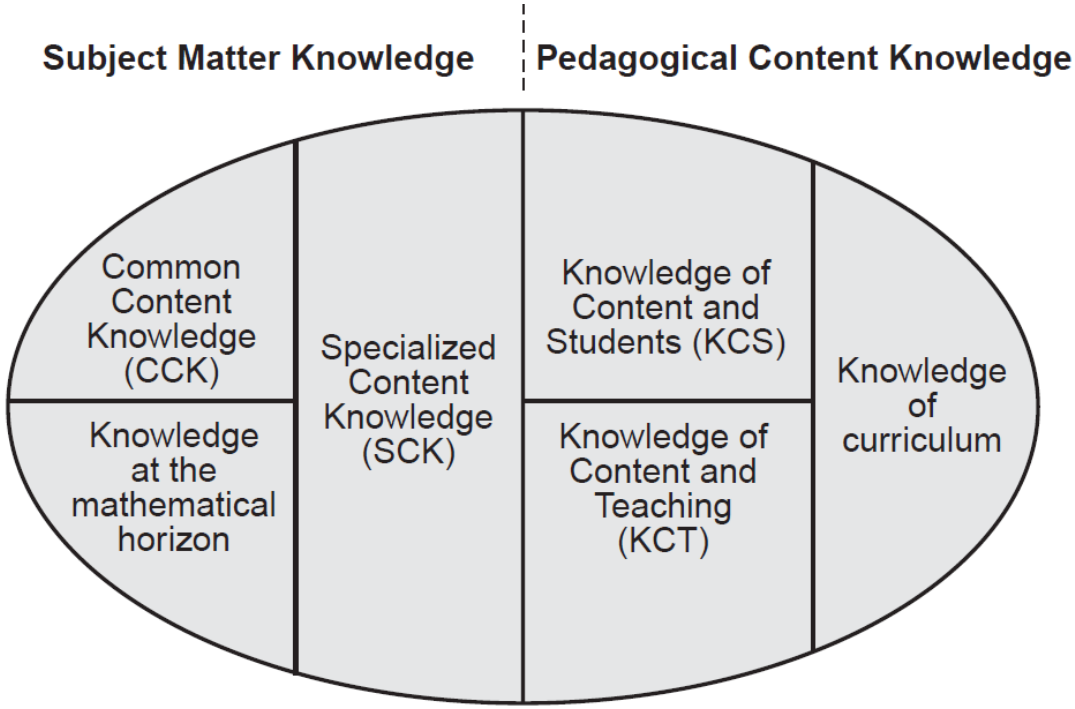
- Availing epistemic beliefs in mathematics have been thought to promote reform-based teaching.
  (Gill et al., 2004)

MKT

- 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)



MKT (cont.)

- A positive statistically significant association has been found between elementary teachers' MKT and student performance. (Hill, Rowan, & Ball, 2005)

- MKT measured by the Learning Mathematics for Teaching (LMT) assessment

Sample LMT Item

25. As an early introduction to mathematical proof, Ms. Cobb wants to engage her students in deductive reasoning. She wants to use an activity about the sum of the angles of a triangle, but her students have not yet learned the alternate interior angle theorem. They do, however, know that a right angle is 90 degrees and that a point is surrounded by 360 degrees. Which of the following activities would best fit her purpose? (Circle ONE answer.)

a) Have students draw a triangle and a line parallel to its base through the opposite vertex. From there, have them reason about the angles of the triangle and the angles the triangle makes with the parallel line.

b) Have the students use rectangles with diagonals to reason about the sum of the acute angles in a right triangle.

c) Have students use protractors to measure the angles in several different triangles and from there reason about the sum of the angles of a triangle.

d) Have students cut out a triangle then tear off the three corners and assemble them, and from there reason about the sum of the angles of a triangle.

Sample LMT Item (cont.)

17. Students sometimes remember only part of a rule. They might say, for instance, “two negatives make a positive.” For each operation listed, decide whether the statement “two negatives make a positive” sometimes works, always works, or never works. (Mark SOMETIMES, ALWAYS, NEVER, or I’M NOT SURE)

	Sometimes works	Always works	Never works	I’m not sure
a) Addition	1	2	(3)	4
b) Subtraction	(1)	2	3	4
c) Multiplication	1	(2)	3	4
d) Division	1	(2)	3	4

Teacher Background

- Experience
  - Novice (0-5 years)
  - Experienced (6 years or more)
- Educational background in subject matter
  - Undergraduate major
  - Graduate degree
  - College hours

Gap

- No studies identified to date have examined the varying effects of each aforementioned belief on students' mathematics achievement.

- Findings suggest that certain beliefs may be more strongly related to students' mathematics achievement.
  - Teachers' epistemic beliefs about mathematics were strongest predictor of a teachers' MKT. (Corkin, Ekmekci, & Papakonstantinou, 2015)

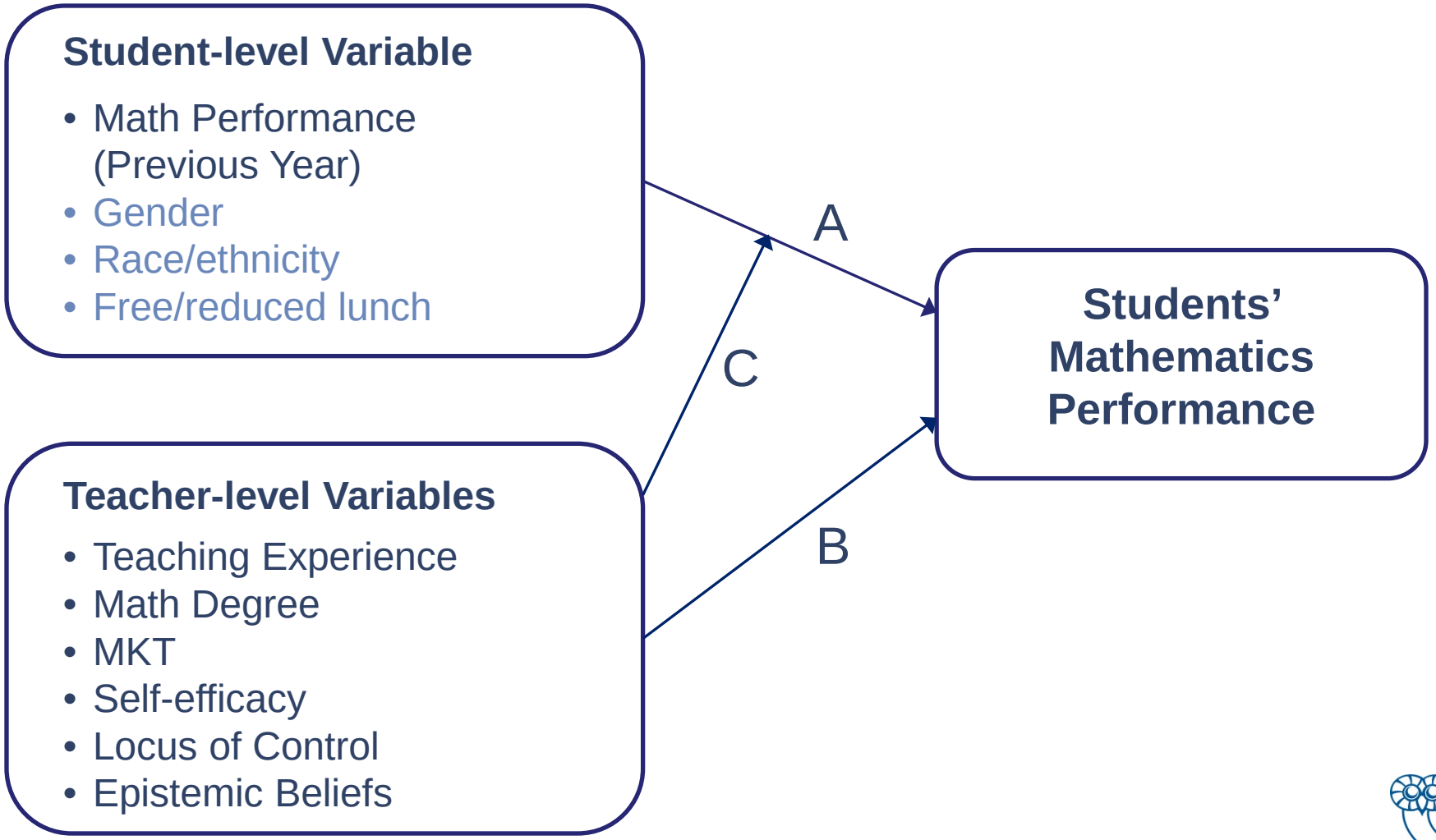
Research Questions

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



Professional Development

- Three-week summer intervention (2013)
- To improve teachers' mathematical knowledge for teaching (MKT)

MKT
(Hill et al., 2008) → subject matter knowledge
pedagogical content knowledge

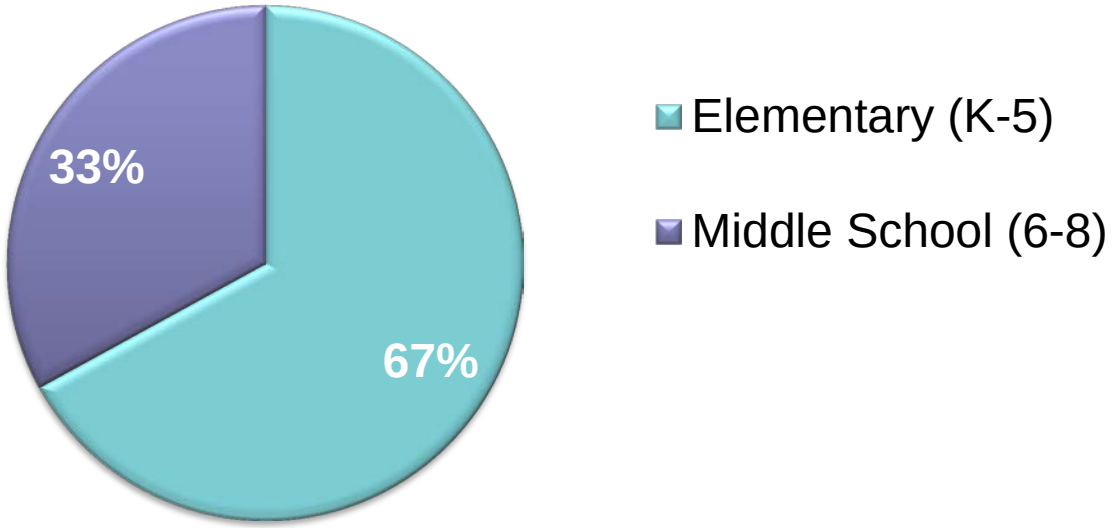
Surveys and Data

- 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 (HERC):
  - Student NCE scores on Stanford 10-Math

Participants

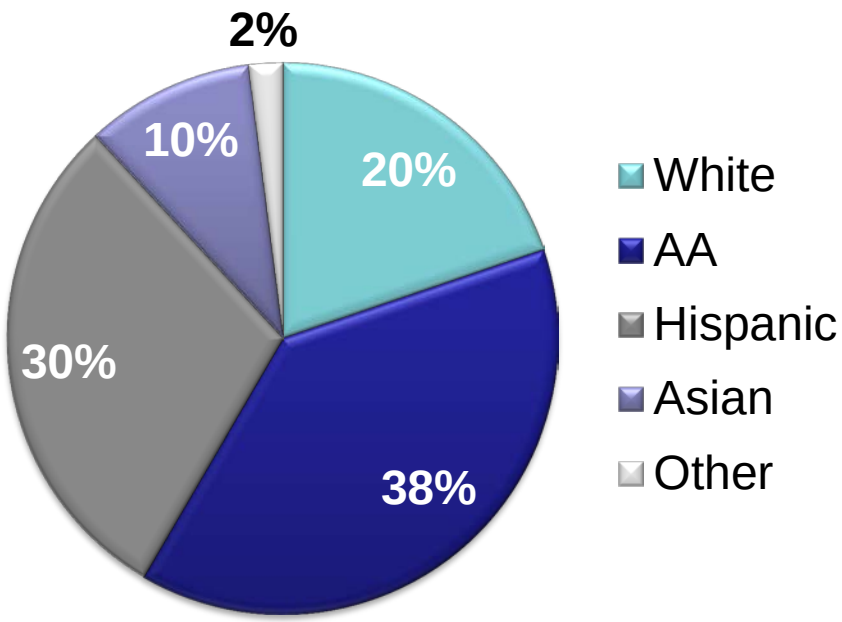
- This study included 34 HISD K-8 teachers from the pool of 80 K-12 math teachers who participated in a summer professional development (PD) program.

School Level of Teachers Included in the study

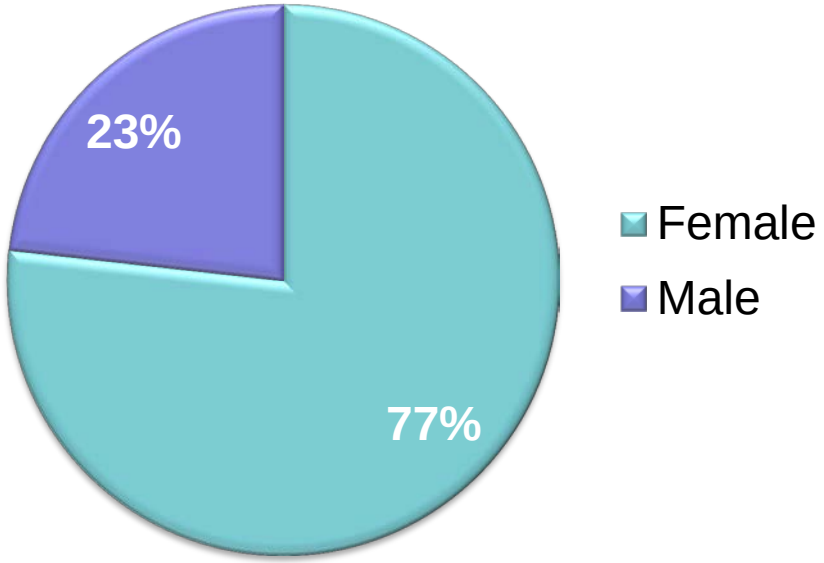


Participants (cont.)

Demographic Breakdown of Participating Teachers



Gender of Participating Teachers



Participants (cont.)

Descriptive Statistics for All Student-Level and Teacher-Level Variables

	Mean	*SD*	*Min*	*Max*
Teacher-Level Variables:				
Self-Efficacy	4.30	0.45	3.23	4.92
Locus of Control	3.77	0.45	3.00	4.75
Epistemic Beliefs (Non-Availing)	2.19	0.51	1.00	3.14
LMT	-0.21	0.94	-2.06	1.96
Math Degree	0.06	0.24	0	1
Years of Teaching	7.06	6.66	0	24
n = 34 teachers.				
Student-Level Variables:				
NCE, Stanford Math 13-14	55.65	20.57	1	99
NCE, Stanford Math 12-13	54.71	20.57	1	99
Female	0.49	0.50	0	1
Asian	0.06	0.24	0	1
Black	0.26	0.44	0	1
Hispanic	0.58	0.49	0	1
Multiracial	0.00	0.05	0	1
White	0.08	0.28	0	1
Economically Disadvantaged	0.76	0.43	0	1
Middle School (6-8)	0.67	0.47	0	1
n = 2,230 students.				

Results

Independent Variable	Model 1 (unconditional) Coeff	SE	Model 2 (within teacher) Coeff	SE	Model 3 (between teacher) Coeff	SE
Fixed Effects						
Intercept	55.61**	1.91	55.61**	1.9	56.5**	1.38
Prior Math Achievement			16.53**	0.46	16.63**	0.47
Years of Teaching					1.55	1.18
Math Degree					4.04*	1.18
LMT					7.89**	1.47
Self-Efficacy					-0.45	1.46
Locus of Control					1.23	1.25
Epistemic Beliefs (Non-Availing)					3.29	1.49
Prior Math Achievement X						
Years of Teaching					-0.24	0.43
Math Degree					-0.22	0.46
LMT					0.18	0.53
Self-Efficacy					0.23	0.54
Locus of Control					0.01	0.48
Epistemic Beliefs					0.42	0.54
Random Effects (Variance Components)						
Student-level effect r_{ij} (σ^2)	309.27**	9.33	109.03**	3.31	109.01**	3.31
Intercept Teacher mean, u_{0j}	115.94**	29.73	119.54**	29.58	51.21**	13.00
Variance explained	27%		65%		57%	
AIC	19225		16972		16966	

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

Arrow A

Arrow B

Arrow C

Results (cont.)

- 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

Next Steps for Analysis

- Follow-up analysis will include examining other student level variables:
  - Gender
  - Socioeconomic status
  - Race/ethnicity

Conclusion

Findings may provide practical implications for the Houston Independent School District related to the recruitment and professional development of mathematics teachers.

Research in Progress
and
Completed Papers

Work in Progress

Corkin, D. & Ekmekci, A. (in progress). Mathematics teachers' motivational beliefs: The effect of the school-work environment.

Corkin, D., Ekmekci, A., & Coleman, S. (in progress). A qualitative study examining the barriers to implementation of constructivist teaching approaches among mathematics teachers in a high-poverty urban school district.

Ekmekci, A., & Corkin, D. (in progress). The collective effects of teachers' educational beliefs and mathematical knowledge on students' mathematics achievement.

Completed Papers

Corkin, D., Ekmekci, A., & Papakonstantinou, A. (2016). *Mathematics teachers' motivational beliefs: The effects of the school-work environment*. Paper to be presented at the 2016 Annual Meeting of American Educational Research Association (AERA). Washington, DC.

Corkin, D., Ekmekci, A., White, C., & Fisher, A. (2016). Teachers' self-efficacy and knowledge for the integration of technology in mathematics instruction at urban schools. In K. Adolphson & T. Olson (Eds.), *Proceedings of the 43rd Annual Meeting of the Research Council on Mathematics Learning*, (pp. 101-108). Orlando, FL.

Completed Papers (cont.)

Corkin, A., Ekmekci, A., & Papakonstantinou, A. (2015). Antecedents of teachers' educational beliefs about mathematics and mathematical knowledge for teaching among in-service teachers in high poverty urban schools. *Australian Journal of Teacher Education, 40*(9), 31-62.

Ekmekci, A., Corkin, D., & Papakonstantinou, A. (2015). The collective effects of teachers' educational beliefs and mathematical knowledge on students' mathematics achievement. In T. Bartell, K. Bieda, R. Putnam, K. Bradfield, & H. Dominguez, (Eds.), *Proceedings of the 37th annual meeting of the PME-NA*, (pp. 884-887). East Lansing, MI: Michigan State Univ.

Completed Papers (cont.)

Ekmekci, A., Corkin, D., & Papakonstantinou, A. (2015). The relationship between teacher related factors and mathematics teachers' educational beliefs about mathematics. In S. M. Che, & K. A. Adolphson (Eds.), *Proceedings of the 42nd Annual Meeting of the RCML,* (pp. 140-148). Las Vegas, NV: Univ. of Nevada.

Ekmekci, A., Corkin, D., & Papakonstantinou, A. (2015). *Technology using habits of mathematics teachers.* Paper presented at the 2015 Annual Meeting of American Educational Research Association (AERA). Chicago, IL.

THANK YOU !

Danya Corkin
dmc7@rice.edu

Adem Ekmekci
ae16@rice.edu

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