TEACHER SUBJECT-MATTER KNOWLEDGE AND YEARS OF EXPERIENCE—NOT GROWTH MINDSET ABOUT STUDENTS—PREDICT STUDENT LEARNING IN FRACTIONS

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Background

Teachers' years of teaching experience has been known to be positively associated with student learning (Harris & Sass, 2011; Rockoff, 2004; Papay, & Kraft, 2015). Many scholars claim that teachers' mathematical knowledge for teaching (MKT) and growth mindset (GM) exert a positive effect on student learning (Ball, Thames, & Phelps, 2008; Dweck, 2006; Hochanadel & Finamore, 2015; Rattan, Savani, Chugh, & Dweck, 2015; Yeager et al., 2019). Large-scale, empirical studies have produced comparatively little empirical evidence of their relationship with student learning (Sisk, Burgoyne, Sun, Butler, & Macnamara, 2015).

Research Question

To what extent do intermediate-grades teachers' years of experience, MKT, and GM with respect to students' mathematical abilities predict their students' learning in fractions?

Setting

Third- and fourth-grade teachers (and their students) in 10 states participated in a randomized controlled trial of lesson study and fractions resource kits between 2016–2018. The estimated effects of the intervention on average MKT, GM, and student achievement was in all cases very close to zero. The present study does not look at the impact of the intervention, and the intervention-group membership was ignored in the current analysis.

Participants

Eighty teachers, representing 80 schools, and 1385 of their mathematics students participated in the study. Due to loss of cases with missing data at the student and/or teacher level, the analytic sample for the present study consisted of 65 teachers and 1046 students. There were 556 girls in the analytic sample, and 505 of the students were third graders (see Table 1 for more descriptive statistics).

Data Sources

Pretest data and consent to participate were collected before fractions instruction occurred for the year. Teachers completed the Knowledge for Teaching Early Fractions (K-TEF) test, which focused on content knowledge for teaching early fractions concepts (Schoen et al., 2018). Teachers also completed a four-item questionnaire designed to assess their growth mindset with respect to student learning with a specific focus on mathematics. Dimensionality analyses supported unidimensionality, and non-linear SEM reliability coefficient proposed by Green and Yang (2009) was calculated to be .75. Students completed two different forms of the Early Fractions Test (EFT; Schoen et al., 2017a; 2017b), one before fractions instruction occurred, and one after. Teacher and student responses to the questionnaires and the tests were calibrated using item response theory models.

Table 1
Descriptive Statistics for Level-1 and Level-2 Variables (n = 1046 students in 65 schools)

Variable	Description	Mean	*SD*	Min	Max
	Level 2 (school/class/teacher)				
%FRL	Percentage of students in school eligible for free or reduced-price lunch	0.63	0.25	0.15	1
GM	Teacher growth mindset	0.17	0.78	-1.24	1.11
MKT	Mathematical knowledge for teaching	0.11	0.85	-1.59	1.99
Experience	Years of teaching experience	12.39	7.65	1	32
Departmentalization	Teacher specializes in mathematics	0.31	0.47	0	1
Degree	Teacher has masters or specialist degree	0.51	0.50	0	1
MathCert	Teacher holds certificate in mathematics	0.08	0.27	0	1
Grade 4	Fourth-grade mathematics class	0.49	0.50	0	1
ClassPre	Class mean pretest score	-0.02	0.65	-1.09	1.45
ClassPost	Class mean posttest score	0.97	0.51	-0.12	2.00
	Level 1 (student)				
ELL	Identified as English-language learner	0.18	0.39	0	1
Female	Coded as 1 for female student	0.53	0.50	0	1
Pre	Student pretest score	0.07	0.90	-1.92	2.63
Post	Student posttest score	1.04	0.79	-1.08	2.69

Data Analysis

We first examined descriptive statistics and correlations among level-2 variables. We then fitted a series of multilevel models to the data using HLM 7 (Raudenbush, Bryk, Cheong, Congdon, & du Toit, 2011).

Results

Table 2
Correlations among Level-2 Variables

	ClassPost	GM	MKT	Experience	Dept	Degree	MathCert	%FRL	Grade4
ClassPre	.77**	.31*	.06	.01	.07	-.07	.10	-.36**	.68**
ClassPost		.24	.19	.18	.09	.07	.09	-.41**	.46**
GM			.02	.14	-.11	-.03	.15	-.09	.29*
MKT				.14	-.07	.14	.01	-.33**	-.05
Experience					-.23	.13	.09	-.27*	-.19
Dept						.06	-.07	.05	.01
Degree							.17	-.06	-.02
MathCert								-.11	.06
%FRL									-.10

Note. ClassPre= mean pretest score at class level; ClassPost = mean posttest score at class level; GM = growth mindset; MKT = mathematical knowledge for teaching; Experience = years of teaching experience; Dept = departmentalization; Degree = the highest degree teacher received; MathCert = subject-specific certification in mathematics; %FRL = percentage of students in school eligible for free or reduced-price lunch.
* $p < .05$, ** $p < .01$

Table 3
Parameter Estimates of Fixed and Random Effects of Multilevel Model Analyses for Posttest Scores

Fixed effect	Model 1		Model 2		Model 3	
	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.
Intercept	0.99***	0.06	0.99***	0.04	0.99***	0.04
ClassPre			0.60***	0.07	0.60***	0.05
GM			0.00	0.04		
MKT			0.05†	0.03	0.07*	0.03
Dept			0.06	0.08		
Degree			0.07	0.07		
MathCert			-0.04	0.06		
Grade4			-0.02	0.10		
Experience			0.01*	0.00	0.01**	0.00
PCT_RFL			-0.11	0.16		
Pretest slope			0.63***	0.03	0.63***	0.03
ELL slope			-0.06	0.06	-0.06	0.06
Female slope			-0.06	0.03	-0.04	0.03
Random Effect	Model 1		Model 2		Model 3	
	d.f.	Variance	*d.f.*	Variance	*d.f.*	Variance
Intercept	64	0.22***	55	0.08***	61	0.07***
Level-1 Residual		0.41		0.24	0.24	

Note. ClassPre= mean pretest score at class level; ClassPost = mean posttest score at class level; GM = growth mindset; MKT = mathematical knowledge for teaching; Experience = years of teaching experience; Dept = departmentalization; Degree = the highest degree teacher received; MathCert = subject-specific certification in mathematics; %FRL = percentage of students in school eligible for free or reduced-price lunch.
† $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$.

Conclusions

We found that teachers' subject-matter knowledge and years of experience—but not their growth mindset about their students—were significant predictors of their students' learning in mathematics.