Teacher Comfort and Preparedness for Teaching Diverse Students: Setting the Foundation for Equitable Classroom Practices

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Abstract

Comfort and preparedness are dispositions that along with teacher knowledge, comprise teacher quality (cf. Clarke & Hollingsworth, 2002). Professional development programs that help teachers understand and respond to individual students' strengths and needs can support equity in the classroom by building teachers' preparedness and comfort, which enhances the likelihood of teachers' engaging in differentiated instruction to support all students. This paper draws from two randomized controlled trials (RCTs) of *Math for All*, which show consistent, positive results of the professional development (PD) program on elementary school teachers' reports of comfort and preparedness to teach mathematics to diverse students. We found comfort and preparedness to be modestly but consistently related to self-reported mathematical instructional practices across both studies. The fact that the results were similar across the two RCTs even though the modes of delivery differed (PD led by developers in RCT #1; by local staff developers and teacher leaders in RCT #2) also speaks to the scalability of the *Math for All* program.

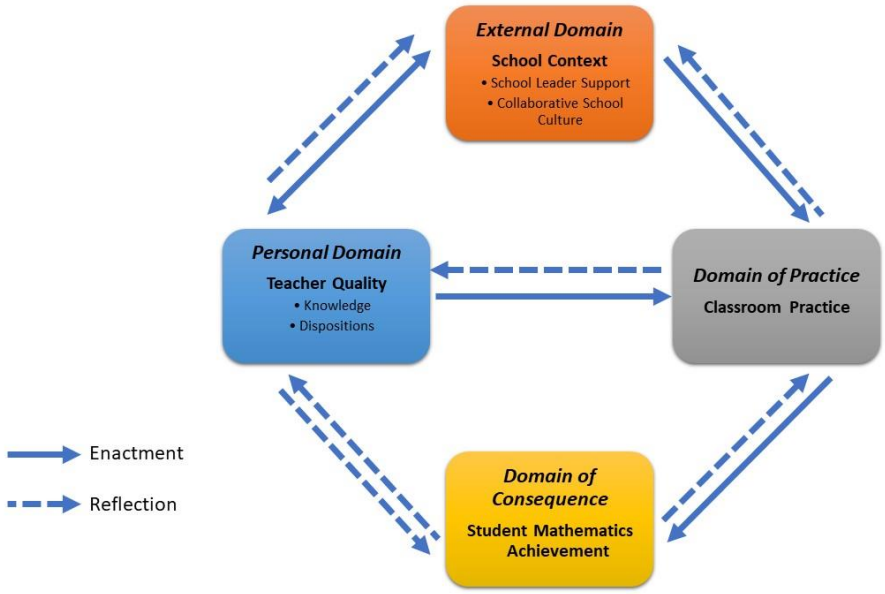
Objectives

The goal of this paper is to present data from two randomized controlled trials (RCTs) of the *Math for All* (MFA) professional development (PD) program. MFA is an intensive PD program designed to help general and special education teachers in Grades K–5 personalize rigorous mathematics instruction for a wide range of learners, including students who are low performing, and students with disabilities. PD programs that help teachers understand and respond to individual students' strengths and needs can support equity in the classroom by building teachers' preparedness and comfort, which enhances the likelihood of teachers' engaging in differentiated instruction to support all students. The results from these two RCTs show consistent impacts of the MFA PD on teacher preparedness and comfort, which in turn are modestly and positively correlated to instructional practices.

As we seek to understand the impacts of PD on teacher and student outcomes, it is important to "open the black box" and flesh out the mechanisms by which PD can affect teacher practice (which in turn, affects

student achievement). Clarke & Hollingsworth (2002) propose that teacher quality, along with school context, classroom practice, and student mathematics achievement, are the key components to consider when conceptualizing teachers' professional growth, which is an ongoing, dynamic, and interactive enterprise. As shown in Figure 1, comfort and preparedness are dispositions that along with teacher knowledge, comprise teacher quality (Clarke & Hollingsworth, 2002).

Figure 1. Dynamic model of teachers' professional growth (adapted from Clark & Hollingsworth 2002 and Goldsmith et al. 2013)



Theoretical Framework

Research shows that teacher quality is the single most powerful influence on student learning (e.g., Nye et al., 2004; O'Dwyer et al., 2010; Rivkin et al., 2005). Yet teachers report that they are not well prepared to implement standards-based mathematics education with the heterogeneous groups of students often found in general education classrooms, including students with disabilities and students with different capabilities and needs. In a national survey of science and mathematics teachers, Banilower et al. (2018) found that only 41% of elementary school math teachers felt well prepared to differentiate mathematics instruction to meet the needs of diverse learners, and 15% felt well prepared to incorporate students' cultural backgrounds into mathematics instruction. Notably, these results are consistent with an earlier national survey, suggesting this is a long-term concern (Banilower et al., 2013).

Given teachers' self-reported lack of preparation to teach high-quality mathematics to diverse learners, it is not surprising that mathematics achievement in the United States is low, especially for high-need student populations. According to recent data from the National Assessment of Educational Progress (NAEP) (U.S. Department of Education, 2019), mathematics achievement levels for students with disabilities, and those from low-income families are among the lowest of all U.S. students (Table 1).

Table 1

2019 NAEP Mathematics Assessment Results

Student Group Scoring Proficient or Higher	Grade 4	Grade 8
All Students	41%	34%
Low Income (National School Lunch Program)	26%	18%
Students with Disabilities	17%	9%

These numbers are alarming. Mathematics is essential for functioning in everyday life and is a prerequisite to many 21st-century careers. Research has shown that mathematics achievement is closely linked with overall student success, such as achievement in high school, high school graduation, college readiness, and students' career aspirations (e.g., Balfanz et al., 2007; Lee, 2012; Shapka et al., 2006; Siegler et al., 2012). Thus, the low mathematics achievement of high-need student populations threatens to limit their opportunities to excel in an increasingly technology-based society.

Methods

Intervention

PD programs that are embedded in subject area content and focus on how students learn content have been found more likely to change classroom practices and enhance student outcomes, relative to approaches that focus mainly on the processes for delivery of instruction (Cohen & Hill, 1998; Corcoran, 1995; Garet et al., 2001; Kennedy, 1998). MFA prepares grade K–5 teachers to help students with diverse strengths and needs—including those with disabilities—who are being served in general education classrooms achieve high-quality, standards-based learning outcomes in mathematics. The MFA program is designed to have a direct impact on teachers' knowledge, skills, and classroom practice. The PD introduces teachers to a neurodevelopmental framework (Barringer et al., 2010; Levine, 2002; Pohlman, 2008) as a lens for better understanding individual students' strengths and needs and the demands of mathematical activities. It also engages teachers in in-depth analyses of math lessons, including examination of their mathematical goals, and different kinds of instructional strategies and teaching practices that support the attainment of these goals while being attuned to individual students' strengths and needs.

MFA was developed by Bank Street College and EDC with funding from the National Science Foundation and is published by Corwin Press (Moeller et al., 2011a; 2011b; 2012; 2013a; 2013b). MFA incorporates several components that randomized controlled trials (RCTs) or quasi-experimental studies (QEDs) have shown to be effective for supporting elementary school teachers' professional learning and for improving student achievement, particularly teacher collaboration for instructional planning and peer coaching (cf. Stevens & Slavin, 1995).

This paper draws from two RCTs of MFA, which show consistent, positive results of the PD program on elementary school teachers' reports of comfort and preparedness to teach mathematics to diverse students, and consistent, positive correlations between comfort, preparedness, and instructional practices.

Data Sources

RCT #1. In fall 2014, the Institute of Education Sciences (IES) funded an efficacy trial of MFA to help build the knowledge base on the impact of PD interventions (Duncan et al., 2018). The study took place during the 2015–16 and 2016–17 school years, involving 32 schools from a large urban school district in the Midwest and 80 4th and 5th grade general and special education teachers. Because of attrition that occurred between the first and second years of the study, we focus on results recorded after the first year of the study, where causal validity is strongest. Note that this RCT did find a compelling student-level effect size on achievement (ES = 0.327) but this was not a statistically significant result because it is a cluster-level contrast with a sample size of 32.

RCT #2. In fall 2018, the authors received a mid-phase Education Innovation Research (EIR) grant from the U.S. Dept. of Education. The overall goal of this project is to implement, test, and refine strategies for regionally expanding MFA in a variety of settings and with diverse populations. We report results from the 2019-20 school year, involving 17 schools (11 in a large urban district and 6 in several rural districts in a midwestern state) and 153 general and special education teachers in grades K through 5. MFA PD was randomly assigned to be delivered either at the K-2 or 3-5 grade band. Student achievement data are not available for the 2019-20 school year because state assessments were cancelled due to the COVID-19 pandemic.

Measures

For both RCTs, we administered a teacher survey at the beginning and end of the school year that included measures of teacher preparedness and comfort (Table 2). We also administered instructional logs that asked teachers to report on their practices at the end of several targeted weeks (Table 3). The number of logs completed by individual teachers varied, so we computed averages for teacher practices to correlate with preparedness and comfort. Internal consistency of all three scales is high, as measured by the Cronbach alphas shown in Table 4.

Table 2

Preparedness and Comfort Scales

a. Teaching standards-based math to students with disabilities.
b. Identifying the math strengths of students with disabilities.
c. Identifying the math needs of students with disabilities.
d. Understanding the mathematics of the lessons I teach.
e. Analyzing the demands of mathematical tasks on students.
f. Determining the goals of the math lessons I teach.

g. Understanding learning trajectories in mathematics (how the math I teach relates to what students learned before and what they will learn later).
h. Selecting specific strategies to address the strengths of students with disabilities in math.
i. Selecting specific strategies to address the needs of students with disabilities in math.
j. Adapting math lessons for students with disabilities to help them meet standards-based goals.
k. Collaborating with my colleagues when planning math lessons.

Note. Items are rated on 1-5 Likert scales, anchored by 1=not at all prepared to 5=very prepared, or 1=not at all comfortable to 5=very comfortable

Table 3

Instructional Practices Measure

a. Observe individual students to identify strengths and needs.
b. Analyze student work samples to identify strengths and needs.
c. Share assessment data with students.
d. Encourage students to reflect on their learning.
e. Give information using multiple modalities (e.g., visual, verbal, written).
f. Use graphics and visual organizers to represent math concepts and problems.
g. Allow students to express their ideas in multiple modalities.
h. Offer assignments with different levels of difficulty for different students.
i. Allow for students to engage with the lesson materials in multiple ways.
j. Have students explain their thinking by talking, writing, or drawing the steps they used in solving a problem.
k. Have students solve problems and discuss mathematics in small groups.
l. Group students so they can provide peer support.
m. Clearly communicate expectations for learning.
n. Systematically and explicitly teach the steps and strategies for problem solving.
o. Evaluate how specific strategies are working for individual students.
p. Reflect on my practice.

Note. Items are rated on the following frequency scale: 0=Never; 1=Once; 2=Twice; 3=Three Times; 4=Four Times; 5=Daily

Table 4

Scale Reliability Statistics

	Standardized Cronbach Alpha			
Scale	**Fall 2015**	**Spring 2016**	**Fall 2019**	**Spring 2020**
Preparedness	0.925	0.943	0.909	0.910
Comfort	0.930	0.954	0.928	0.926
Instructional Practices	0.841	0.881	0.886	0.946

Results

Across both RCTs, we tested multilevel models (MLMs) that included the baseline scores and an indicator for study condition (MFA PD or business as usual [BAU]). Please refer to the figure notes for details about the statistical analyses.

The findings from the two studies are presented in four graphs in Figures 2 and 3. Graphs A and B compare the overall results of the two RCTs, while Graphs C and D break out the results of Graph B to show differences between the lower and upper elementary grade bands.

a) Results from the 2015-2016 school year (80 grades 4 and 5 teachers)
b) Results from the 2019-20 school year (153 K-5 teachers)
c) Results from the 2019-20 school year (94 K-2 teachers)
d) Results from the 2019-20 school year (59 grades 3-5 teachers)

Teachers' Reports of Preparedness to Teach Mathematics to Diverse Students

In both studies, we found statistically significant results of the MFA PD on teachers' preparedness to teach mathematics to diverse students. Teachers in the BAU groups reported either lower or unchanged levels of preparedness to teach mathematics to diverse students. In contrast, teachers who participated in the MFA PD reported substantive increases in their preparedness (Figures 2a through 2d).

Teachers' Reports of Comfort with Teaching Mathematics to Diverse Students

In both studies, we found statistically significant results of the MFA PD on teachers' comfort with teaching mathematics to diverse students. Teachers in the BAU groups reported either lower or unchanged levels of comfort, while teachers who participated in the MFA PD reported significant increases in their comfort with teaching mathematics to diverse students (Figures 3a through 3d).

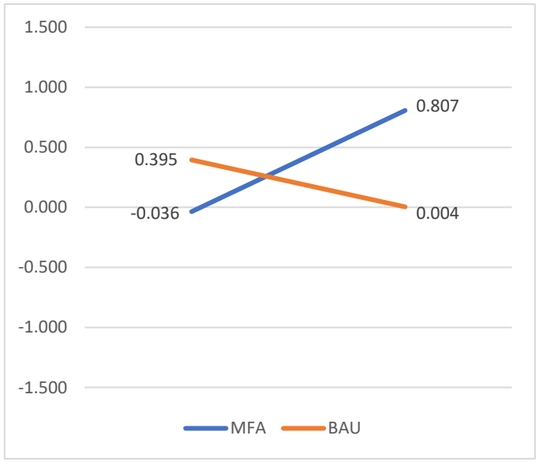
Relationships between Teacher Dispositions and Instructional Practices

Correlations between teacher instructional practices with comfort and preparedness to teach diverse students are displayed in Table 5. Although the correlations between preparedness and comfort and instructional practices are modest, the correlations are consistent across the two studies. In both studies and across sub-groups in RCT #2, the correlations obtained in the spring are stronger than those obtained in the fall.

Figure 2. Impact of MFA PD on participating teachers' **preparedness** for teaching mathematics to diverse students

2a. 2015-2016 School Year: Preparedness Results from RCT #1 (Grade 4 and 5 Teachers)

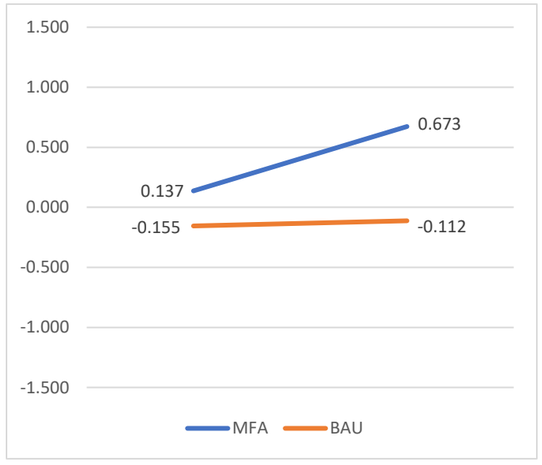
Group	Fall 2015 Preparedness Mean Score	Fall 2015 Preparedness SD	Spring 2016 Preparedness Unadj. Mean Score	Spring 2016 Preparedness Adj. Mean Score	Spring 2016 Preparedness SD	Hedges' g	p-value
MFA	-0.036	1.193	0.748	0.807	1.322		
BAU	0.395	1.180	0.060	0.004	1.623	0.541	0.013



Note. Multilevel model with the Preparedness dependent variable, including the treatment indicator, the baseline Preparedness variable, enjoy teaching math, an indicator denoting the teacher as a SWD teacher, and a school-level mean baseline Preparedness variable. The model also included a random intercept, making use of n =37 BAU teachers and n =43 MFA teachers. The baseline difference for the analytic sample was computed as g = -0.36. Because of the size of this baseline difference, this finding should be interpreted with caution.

2b. 2019-2020 School Year: Preparedness from RCT #2 (Grades K – 5 Teachers)

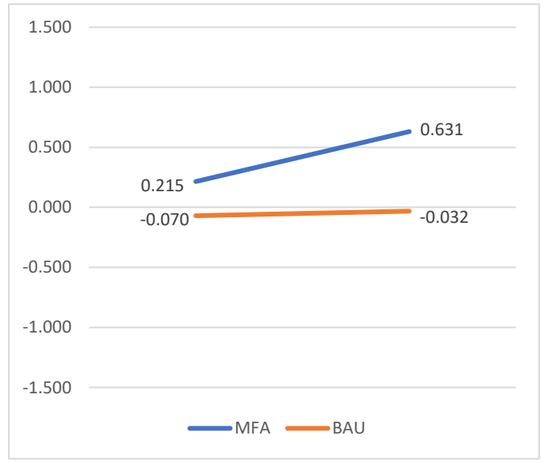
Group	Fall 2019 Preparedness Mean Score	Fall 2019 Preparedness SD	Spring 2020 Preparedness Unadj. Mean Score	Spring 2020 Preparedness Adj. Mean Score	Spring 2020 Preparedness SD	Hedges' g	p-value
MFA	0.137	1.995	0.772	0.673	2.315		
BAU	-0.155	1.617	-0.198	-0.112	1.530	0.380	0.007



Note. Multilevel model with cohort-by-district block included in the model as a predictor (n = 58 BAU teachers and n = 95 MFA teachers). The baseline difference for the analytic sample was computed as g = 0.156.

2c. 2019-2020 School Year: Preparedness from RCT #2 (Grades K – 2 Teachers)

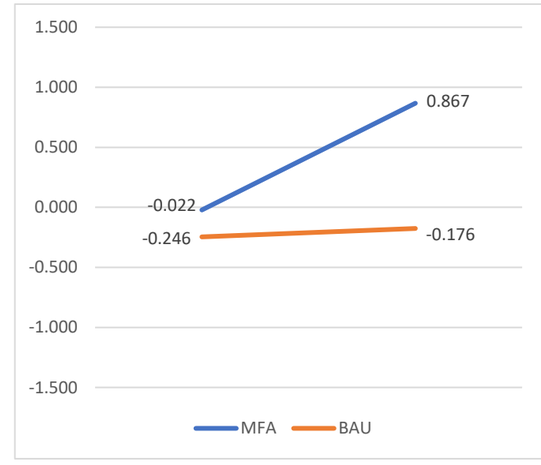
Group	Fall 2019 Preparedness Mean Score	Fall 2019 Preparedness SD	Spring 2020 Preparedness Unadj. Mean Score	Spring 2020 Preparedness Adj. Mean Score	Spring 2020 Preparedness SD	Hedges' g	p-value
MFA	0.215	1.973	0.735	0.631	2.254		
BAU	-0.070	1.548	-0.108	-0.032	1.474	0.322	0.074



Note. Multilevel model with cohort-by-district block included in the model as a predictor (*n* = 30 BAU teachers and *n* = 64 MFA teachers in the K-2 grade band). The baseline difference for the analytic sample was computed as *g* = 0.153.

2d. 2019-2020 School Year: Preparedness from RCT #2 (Grades 3 – 5 Teachers)

Group	Fall 2019 Preparedness Mean Score	Fall 2019 Preparedness SD	Spring 2020 Preparedness Unadj. Mean Score	Spring 2020 Preparedness Adj. Mean Score	Spring 2020 Preparedness SD	Hedges' g	p-value
MFA	-0.022	2.063	0.849	0.867	2.472		
BAU	-0.246	1.712	-0.294	-0.176	1.610	0.488	0.032

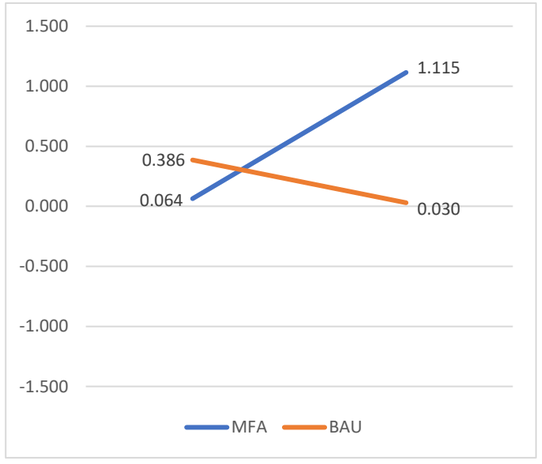


Note. Multilevel model with cohort-by-district block included in the model as a predictor (*n* = 28 BAU teachers and *n* = 31 MFA teachers in the 3-5 grade band). The baseline difference for the analytic sample was computed as *g* = 0.116.

Figure 3. Impact of MFA PD on participating teachers' **comfort** with teaching mathematics to diverse students

3a. 2015-2016 School Year: Comfort Results from RCT #1 (Grade 4 and 5 Teachers)

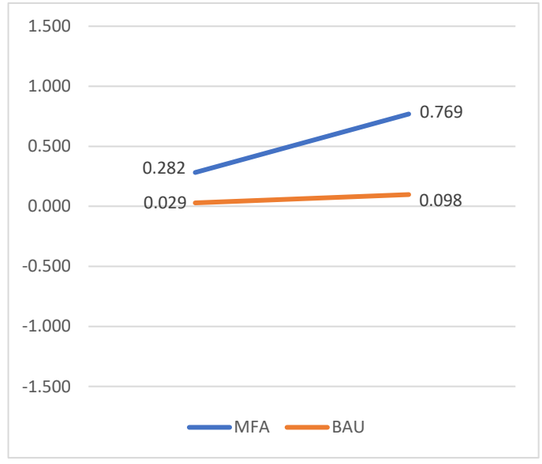
Group	Fall 2015 Comfort		Spring 2016 Comfort			Hedges' g	p-value
	Mean Score	SD	Unadj. Mean Score	Adj. Mean Score	SD		
MFA	0.064	1.297	1.088	1.115	1.442		
BAU	0.386	1.235	0.051	0.030	1.800	0.666	0.005



Note. Multilevel model with the Comfort dependent variable, including the treatment indicator, the baseline Comfort variable, and a variable representing enjoyment for teaching math. The model also included a random intercept, making use of n = 36 BAU teachers and n = 43 MFA teachers. The baseline difference for the analytic sample was computed as g = -0.251.

3b. 2019-2020 School Year: Comfort Results from RCT #2 (Grades K – 5 Teachers)

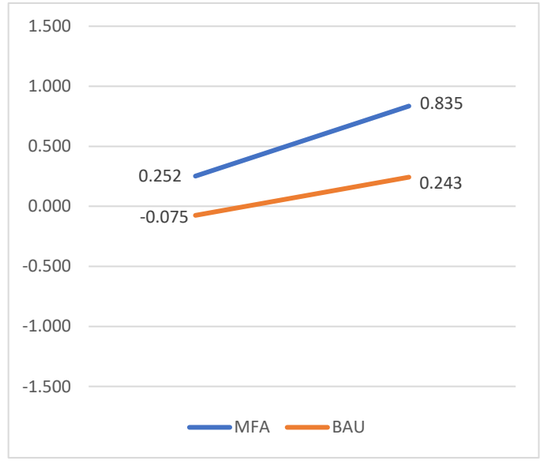
Group	Fall 2019 Comfort		Spring 2020 Comfort			Hedges' g	p-value
	Mean Score	SD	Unadj. Mean Score	Adj. Mean Score	SD		
MFA	0.282	2.322	0.932	0.769	2.480		
BAU	0.029	2.132	0.115	0.098	2.092	0.285	0.051



Note. Multilevel model with cohort-by-district block included in the model as a predictor (n = 57 BAU teachers and n = 95 MFA teachers). The baseline difference was computed as g = 0.112.

3c. 2019-2020 School Year: Comfort Results from RCT #2 (Grades K – 2 Teachers)

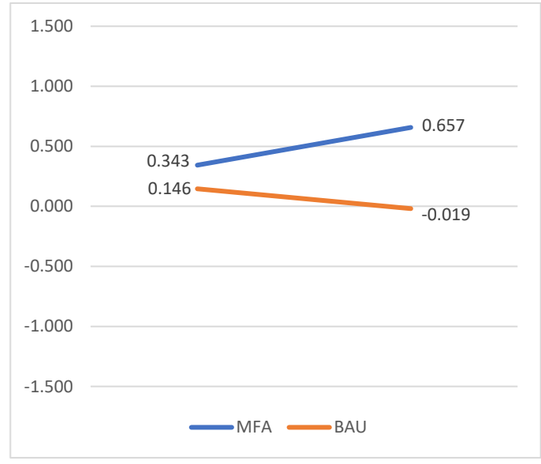
Group	Fall 2019 Comfort		Spring 2020 Comfort			Hedges' g	p-value
	Mean Score	SD	Unadj. Mean Score	Adj. Mean Score	SD		
MFA	0.252	2.307	1.005	0.835	2.581		
BAU	-0.075	1.847	0.226	0.243	2.077	0.241	0.182



Note. Multilevel model with cohort-by-district block included in the model as a predictor (n = 30 BAU teachers and n = 64 MFA teachers in the K-2 grade band). The baseline difference was computed as g = 0.149.

3d. 2019-2020 School Year: Comfort Results from RCT #2 (Grades 3 – 5 Teachers)

Group	Fall 2019 Comfort		Spring 2020 Comfort			Hedges' g	p-value
	Mean Score	SD	Unadj. Mean Score	Adj. Mean Score	SD		
MFA	0.343	2.390	0.781	0.657	2.289		
BAU	0.146	2.441	-0.007	-0.019	2.142	0.300	0.224



Note. Multilevel model with cohort-by-district block included in the model as a predictor (n = 27 BAU teachers and n = 31 MFA teachers in the 3-5 grade band). The baseline difference was computed as g = 0.081.

Table 5

Correlations between Preparedness, Comfort, and Instructional Practices

Scale	Preparedness	Comfort	Instructional Practices
RCT #1: 2015-2016 data (grades 4 and 5 teachers)			
Preparedness	—	0.93*	**0.20**
Comfort	0.92*	—	**0.31***
Instructional Practices	**0.11**	**0.07**	—
RCT #2: 2019-2020 data (grades K-5 teachers)			
Preparedness	—	0.86*	**0.32***
Comfort	0.80*	—	**0.38***
Instructional Practices	**0.25***	**0.23***	—
RCT #2: 2019-2020 data (grades K-2 teachers)			
Preparedness	—	0.88*	**0.31***
Comfort	0.83*	—	**0.39***
Instructional Practices	**0.26***	**0.21***	—
RCT #2: 2019-2020 data (grades 3-5 teachers)			
Preparedness	—	0.83*	**0.34***
Comfort	0.77*	—	**0.38***
Instructional Practices	**0.24***	**0.26***	—

Note. Values below the diagonal are among the fall measures; values above the diagonal are among the spring measures. Asterisks indicate correlations that are statistically significant a $p \leq 0.05$. Readers might wish to interpret these correlations by squaring them (e.g., 0.31 = .0961, or about 10% of the variance in one measure is accounted for by variance in the other).

Discussion

The body of work presented here provides strong causal evidence based on two RCTs that MFA had an impact (i.e., statistically significant, medium to large effect sizes) on teachers' self-reported sense of comfort and preparedness for teaching diverse students. This is critical given repeated survey findings that most teachers report feeling underprepared to work with diverse students (Banilower et al., 2013; 2018) and NAEP findings show large numbers of students are underperforming in mathematics. As argued earlier, poor mathematics achievement can impact long-term individual student outcomes and national competitiveness.

Two key limitations are worth noting. The first is that in RCT #1 there are large baseline differences between the MFA and BAU groups in the comfort and preparedness contrasts. The second limitation is that we do not present student-level achievement outcomes (recall however that the first RCT did show a compelling student-level effect although it was not statistically significant). We were unable to collect student-level data for the second RCT because of COVID-19 but we do have funding necessary under RCT #2 to carry out research with another cohort of schools and teachers.

The consistency of results across both RCTs indicates stability in the patterns of findings, which (a) point to positive impacts of the MFA program on elementary teachers' preparedness for and comfort in teaching mathematics to diverse learners, and (b) demonstrate consistent, modest, positive correlations between preparedness, comfort, and instructional practices. The positive correlations between teacher dispositions and instructional practices complement prior reports of the positive impact of MFA on instructional

practices, as measured via classroom observations of mathematics lessons and scores using the CLASS rubric (Duncan et al., 2018). The fact that the results were similar across the two RCTs even though the modes of delivery differed (PD led by developers in RCT #1; by local staff developers and teacher leaders in RCT #2) also speaks to the scalability of the *Math for All* program.

As we seek to understand the impacts of PD on teacher and student outcomes, it is important to "open the black box" and flesh out the mechanisms by which PD can affect teacher practice (which in turn, affects student achievement). The data presented here suggest that teacher preparedness and comfort may be key mediators to consider in our models of teacher quality (cf. Clarke & Hollingsworth, 2002).

Disclosures

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