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Spread Too Thin: The Effect of Specialization on Teaching Effectiveness

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Although the majority of elementary school teachers cover all major subjects in self-contained classrooms, a growing number of teachers specialize in teaching fewer subjects to higher numbers of students. We use administrative data from Indiana to estimate the effect of teacher specialization on teacher and school effectiveness in elementary schools. We find that teacher specialization leads to lower teaching effectiveness in math and reading, and the negative effects are larger when teaching students who are more likely to experience obstacles in school. Moreover, we find no evidence that increasing the proportion of teacher specialists at the school level generates improvements in indicators of school quality. Our findings underscore the importance of fostering opportunities to develop stronger student–teacher relationships.

Keywords: *at-risk students, child development, educational policy, teacher education/development, regression analyses, secondary data analysis*

Introduction

The majority of U.S. elementary school students learn in self-contained classrooms where one teacher covers all major subjects, whereas secondary school students learn from subject-area specialists who cover fewer subjects. Yet, elementary school teachers typically have expertise in some subjects over others (Cohen et al., 2018; Goldhaber et al., 2013), and a teacher's content knowledge in a particular area predicts higher student achievement (Ball et al., 2008; Campbell et al., 2014). Thus, subject-area specialization has the potential to increase teacher and school effectiveness by leveraging and developing a teacher's subject expertise (Condie et al., 2014; Jacob & Rockoff, 2011).

Although subject-area specialization in elementary schools is conceptually appealing along some dimensions, it does not come without trade-offs. From the perspective of teacher effectiveness, one potential negative consequence is increased student/teacher ratios and the corresponding weakening of student–teacher relationships. Unlike self-contained classrooms that enable teachers to cultivate strong relationships by focusing on fewer students and spending more time with them, subject-area specialization spreads teachers across more students (Bastian & Fortner, 2020). Because strong student–teacher relationships are an important ingredient in positive student growth (Hegde & Cassidy, 2004), the benefits of specialization may not outweigh the advantages of learning from a general classroom teacher.

Educators and policymakers have weighed the benefits and drawbacks of teacher specialization in elementary schools for over a century (Ackerlund, 1959; Lobdell & Van Ness, 1963; Parker et al., 2017), yet there remains little empirical evidence on this understudied topic. Although evidence of differential effectiveness across subjects supports subject area teacher specialization (Condie et al., 2014; Jacob & Rockoff, 2011), recent research from a randomized controlled trial in Houston and a quasi-experimental investigation in North Carolina suggests that specialization can lead to lower teaching effectiveness as measured by teachers' ability to raise student test scores (Bastian & Fortner, 2020; Fryer, 2018). We add to this emerging body of literature by replicating Bastian and Fortner's quasi-experimental approach using 7 years of data from a midwestern state, examining subgroups across a larger set of student characteristics, and looking beyond test scores to examine the effect of specialization rates on school-level attendance and discipline.

Using longitudinal administrative data from the Indiana Department of Education (IDOE) covering the 2010–2011 to 2016–2017 school years, we begin by documenting school and teacher characteristics that are associated with teachers becoming specialists. Next, because we observe the same teachers at different points in time in both general and specialized roles, we test whether subject area teacher specialization (i.e., teaching only one or two subjects in a given year) increases or decreases teaching effectiveness in math and reading. We complement this investigation by considering if the effectiveness of specialists is heterogeneous across a range of different student populations. Finally, because specialization could improve school-level outcomes independent of the effect of specialization on individual teachers' effectiveness, we explore the aggregate effect of teacher specialization rates on a set of school-level outcomes, including student achievement, absences, and disciplinary infractions.

We find few descriptive differences across schools with higher or lower rates of teacher specialization. Counterintuitively, teachers with lower value-added scores and teachers considered not highly qualified by Indiana's Department of Education are more likely to become specialists. For individual teachers, we find clear evidence that they perform worse in specialized teaching roles relative to general roles as measured by their impacts on student achievement in math and reading. Two separate falsification tests provide evidence that our findings are not driven by time-varying performance of teachers and students prior to specialization assignments, supporting our main identification strategy. Importantly, we find that reductions in teaching effectiveness are more severe when educating students who are more likely to face obstacles in school, including racial/ethnic minority students, students who are eligible for free or reduced-price lunch (FRL), English language learners (ELL), students with individualized education programs (IEP), and lower-achieving students. When we examine the aggregate effect at the school level, we find no evidence that schools that increase the proportion of specialists experience improvement in student achievement, absences, or disciplinary infractions.

Background on Teacher Specialization

Discussion regarding the potential benefits of elementary school teacher specialization dates back for more than a century. Although the percentage of elementary schools that implement teacher specialization has varied widely over time (Hood, 2010; Lobdell & Van Ness, 1963), an increasing number of elementary schools assign teachers to fewer subjects and a greater number of students (Gewertz, 2014; Hood, 2010; Parker et al., 2017). In the mid-1990s, only 5% of elementary schools implemented teacher specialization, but that number rose to 20% by the end of the 2000s across U.S. school districts (Hood, 2010).

This growing interest in elementary school teacher specialization is closely linked with the demand for quality teachers. A large body of studies confirm that teacher quality plays a critical role in student learning and development (e.g., Chetty et al., 2014; Jennings & Greenberg, 2009), yet the quality and supply of teachers in the U.S. workforce has been a concern over the past several decades (Corcoran et al., 2004; Hanushek & Pace, 1995).

Two lines of emerging literature provide compelling evidence that supports the advantages of teacher specialization. One line of research demonstrates that a teacher's effectiveness varies across subjects. Although a highly effective teacher in one subject tends to be also highly effective in other subjects, teachers are more effective in some subjects than others (Cohen et al., 2018; Condie et al., 2014). This suggests that assigning teachers to subjects based on their comparative advantages may enhance student learning.

Another hypothesized advantage of specialization is that it should reduce teacher preparation and training burdens. Scholars also show that teaching the same grade repeatedly helps teachers develop their expertise faster (Blazar, 2015; Ost, 2014), whereas teaching multiple grades or managing wider ranges of content preparation hampers their effectiveness (Bastian & Janda, 2018). Because teacher specialization enables teachers to spend more time on a narrower range of content, teacher specialization can also expedite teachers' preparation and professional development by allowing teachers to devote their time to a smaller number of subjects. Teachers report that preparing and teaching fewer subjects reduces stress and increases their job satisfaction (Strohl et al., 2014).

Despite theory and evidence suggesting that teacher specialization is a promising strategy to increase teacher effectiveness, assigning teachers to fewer subjects may come with unintended consequences. Specialists are responsible for teaching more students, making it more difficult for them to learn students' strengths and weaknesses, special circumstances, and needs (Ackerlund, 1959; Culyer, 1984; Vidergor & Azar Gordon, 2015). This lack of student–teacher familiarity likely provides challenging environments for students to build attachments with teachers and develop a sense of school belonging (Allen et al., 2018; Bouchard & Berg, 2017). Research consistently shows that establishing strong relationships with teachers plays an important role in student development by increasing school engagement and connectiveness, particularly in early stages of schooling (Curby et al., 2009; O'Connor & McCartney, 2007; Wu et al., 2010). For parents, not having a single teacher may make it more difficult to communicate regarding the progress of their child's development and learning.

Given these considerations, teacher specialization may have more adverse effects on students from underserved populations. Although relationships with teachers influence the learning of all students, the opportunities to build relationships with teachers can play a greater role for students who face more obstacles (Hamre & Pianta, 2005; Meehan et al., 2003). For example, if students from low-income families have relatively fewer educational resources and support at home, strong bindings with teachers may help offset these challenges (Liew et al., 2010; Murray & Malmgren, 2005). Similarly, academically struggling students likely face greater difficulties if they study with teachers who do not spend enough time with them to know their learning styles and tailor instruction to their particular needs (Liew et al., 2010).

Although discussions regarding the pros and cons of teacher specialization are far from new, rigorous and systematic empirical evidence on the effects of specialization is rare. Two recent studies suggest the costs of teacher specialization outweigh the benefits. Research from a randomized controlled trial involving 46 schools in the Houston Independent School District finds that teacher specialization has adverse effects on average academic achievement and behavioral outcomes (Fryer, 2018). Specifically, students in treatment schools encouraged to adopt specialization experienced a 0.11 *SD* decrease in a combined index of math and reading test scores, and were more likely to be suspended and accrue absences. Despite the strong internal validity of this study, however, the unique urban setting, small sample size, and the nonrandom selection of schools into the study sample limit its external validity.

Related quasi-experimental research examining data from North Carolina's elementary schools also found discouraging results (Bastian & Fortner, 2020). Although the authors found that more effective teachers measured by value-added scores and principal evaluations were more likely to be specialists, teachers were less effective in math (−0.04 *SD*) and reading (−0.01 *SD*) when they taught one or two subjects than when they taught more subjects. Moreover, the North Carolina study found no evidence that increased levels of specialization improved school effectiveness.

We contribute to this growing literature in several important ways. First, similar to Bastian and Fortner (2020), we employ teacher fixed effects models to reveal the effect of teacher specialization on teaching effectiveness using 7 years of data from a different state, which adds to the generalizability of findings regarding teacher specialization. In addition, we conduct a more expansive analysis of effect heterogeneity across a broad range of student characteristics. Specifically, whereas Bastian and Fortner tested for heterogeneity across student poverty levels, we further test for effect heterogeneity among student subgroups defined by minority status, FRL eligibility status, ELL status, IEP status, and prior achievement level. Given that student–teacher relationships are particularly important for students from underserved populations (Egalite & Kisida, 2018; Hamre & Pianta, 2005; Hwang et al., 2021; Meehan et al., 2003), examining whether effects vary across student subgroups provides important insights into teacher specialization practices. Finally, we look beyond test scores to examine the aggregate effect of teacher specialization on a broad range of school-level outcomes, including student achievement, absences, and discipline rates, and we explore potential heterogeneous effects by student achievement levels, student FRL rates, and the enrollment rates of underrepresented minority students.

Data and Sample

We use administrative data from the IDOE from 2010–2011 through 2016–2017 school years. These data include student characteristics (e.g., gender, race/ethnicity, FRL eligibility, and IEP status) and teacher characteristics (e.g., gender, race/ethnicity, education level, subjects taught). The data also include student math and reading test scores from Grades 3 through 5 on the Indiana Statewide Testing for Educational Progress Plus (ISTEP+). We use ISTEP+ test scores, standardized at the student level by subject-grade-year, as our main outcome of interest to assess whether teacher effectiveness in math or reading achievement increases or decreases when teachers specialize in fewer subjects.

Our primary analytic sample includes 15,895 unique math teachers and 17,102 unique reading teachers. We link 591,311 unique students to these teachers. We exclude the 10% of teachers in our sample who co-teach in the classroom (i.e., two teachers teach in one class at the same time) because identifying each teacher's contribution to student outcomes is difficult. Table 1 presents the descriptive statistics for the teachers and students in our analytic sample, which we restrict to teachers in fourth and fifth grade due to the inclusion of lagged student achievement in our analytic models. Following Bastian and Fortner (2020), we define specialists as teachers who teach one or two subjects out of the four major subjects (i.e., math, reading, social science, and science). When teachers teach three or four subjects, we define them as generalists. About 30% of ever-specialists teach math, and 49% of ever-specialists teach reading. We present more detailed information, including details about the number of subjects taught by teachers in a given year, in Appendix Table 1 (available in the online version of this article).

TABLE 1

Teacher and Student Characteristics

Characteristic	Math	Reading
Teacher		
Always specialists (%)	17.5	11.9
Sometimes specialists (%)	12.0	36.7
Never specialists (%)	70.5	51.4
Female (%)	85.0	86.0
Black (%)	4.2	4.3
White (%)	94.4	93.8
Hispanic (%)	1.1	1.2
Other race/ethnicity (%)	0.2	0.8
Teaching experience (years)	11.9	11.9
Graduate degree (%)	43.4	43.4
Highly qualified designation (%)	0.8	0.8
N (Unique teacher observation)	15,895	17,102
Student		
Female (%)	49.1	
Black (%)	11.3	
White (%)	70.9	
Hispanic (%)	11.0	
Other race/ethnicity (%)	9.0	
Free or reduced-price lunch eligibility (%)	50.2	
English language learner (%)	6.7	
Individualized education program (%)	14.0	
N (Unique student observation)	591,311	

Note. These summary statistics are based on unique teacher and student data from 2010–2011 to 2016–2017 academic year in Indiana. Highly qualified teacher designation indicates teachers who are qualified in the subject via (a) passing PRAXIS/NTE, (b) 24 credits/degree in core academic area, or (c) national board certification.

Teachers in our data are mostly female and White, which reflects U.S. teacher demographic characteristics (U.S. Department of Education, 2017). On average, Indiana teachers in our sample have roughly 12 years of experience, and slightly fewer than half have a graduate degree. The students in our sample are more racially/ethnically diverse than the teachers; Black, Hispanic, and other race/ethnicity students make up about 30% of students. Half of the students are FRL eligible, and 7% are designated as ELLs. About 14% of students have IEPs (Table 1).

Analytic Models

Subject-Area Specialization and Teaching Effectiveness

Our primary goal is to estimate the causal effect of subject-area specialization on teaching effectiveness and school improvement. An ideal strategy would compare outcomes for teachers or schools randomly assigned to incorporate specialization to teachers or schools that are not. Such a strategy would rule out the possibility that the timing of assignment to specialization is related to other unobserved factors, or that teachers or schools adopting teacher specialization are a select group with different characteristics than teachers or schools that do not.

Because we do not have random assignment, we leverage quasi-experimental panel data methods to estimate effects that—under the identifying assumptions of our models—carry a causal interpretation. Specifically, we use multiple-layer fixed effects models, with the key layer being fixed effects for individual teachers themselves. The teacher fixed effects isolate identifying variation to occur within teachers only—that is, we identify the effect of specialization by comparing the effectiveness of the same teachers in years when they do and do not specialize.[1] Our identification hinges on the assumption that factors that lead to changes in a teacher's specialization status are unrelated to time-varying changes in their own performance or the expected performance of the students assigned to them, conditional on observed student controls. Our primary specification is as follows:

$$Y_{ijgst} = \beta_1 \text{Specialist}_{jst} + \beta_2 \text{Student}_{ijst} + \beta_3 \text{Teacher}_{jst} + \beta_4 \text{School}_{st} + \delta_j + \theta_g + \rho_t + \epsilon_{ijgst}. \quad (1)$$

Y_{ijgt} represents the standardized math or reading score for student i with teacher j in grade g and school s at time t. Specialist_{jst} is the treatment variable of interest and indicates whether a teacher is a specialist in a given school year in school s at time t. Student_{ijst} includes student characteristics including prior year test scores in math or reading, gender, race/ethnicity, FRL eligibility, students with IEPs, ELL status, and class size. Teacher_{jst} includes whether a teacher has a graduate degree, is new to the school, is designated as highly qualified, and total years of teaching experience. School_{st} includes school size, the percentage of Black and Hispanic students, and the percentage of students who are eligible for FRL. δ_j is a teacher fixed effect, θ_g is a grade fixed effect, and ρ_t is a year fixed effect. ϵ_{ijgst} is the error term, which we cluster at the school level.

We also provide supporting evidence for the internal validity of our identification strategy in the form of two falsification tests. In these falsification tests, we artificially assign teachers to specialist roles in the year prior to their first actual assignment to specialization. Similarly, our second falsification test artificially assigns students to the treatment in the year prior to their first year with a specialist. To implement this test, we simultaneously estimate the effects of the placebo and actual treatments in the same regression. If we observe a significant relationship between these placebo treatment assignments and our outcome measures, this would suggest that teachers or students are assigned to the treatment based on unobserved time-varying factors.

To examine whether the effects of specialization vary by time, we also run models where we include a set of indicators for 1, 2, or 3 or more years since becoming a specialist. These models allow us to test whether the effects of specialization change as teachers accumulate experience in that role. To examine whether teacher specialization and effectiveness vary across student subgroups, we add interaction terms to our models to examine if effects are different for each racial/ethnic group, FRL eligible, students with IEPs, students classified as ELL, and lower-achieving students. We also present models run separately for each subgroup in Appendix Tables 3 and 4 (available in the online version of this article), and the results are qualitatively similar.

Teacher Specialization and School Improvement

Although our teacher fixed effects models estimate the effectiveness from the perspective of an individual teacher's ability to raise student-level achievement, it could still be the case that schools are effectively assigning teachers in ways that improve average school outcomes. For example, though assigning a teacher to a specialist role may lower an individual teacher's average effectiveness, students may still be better off if that teacher is better at a particular subject than the other generalists in the school. We use longitudinal school-grade data and school fixed effects to test whether the percentage of teachers who are specialists in a given year has an effect on school-grade achievement. Moreover, because it is difficult to ascribe behavioral outcomes to individual subject-level specialists, we use this same approach to test the aggregate effects of teacher specialization rates on students' unexcused absences and the percentage of students receiving disciplinary infractions. The following equation presents our school fixed effects specification:

$$Y_{sgt} = \beta_1 \text{Specialization Rate}_{sgt} + \beta_2 \text{School}_{sgt} + \delta_s + \theta_g + \rho_t + \epsilon_{sgt}. \quad (2)$$

Y_{sgt} represents one of the school-grade level outcomes (math achievement, reading achievement, absences, or disciplinary incidents) for school s in grade g at time t. We measure math and reading achievement by aggregating ISTEP+ math and reading scores to the school-grade level. Absences indicate average unexcused days absent at school-grade level, and disciplinary incidents indicate percentage of ever-disciplined students at the school-grade level. $\text{Specialization Rate}_{sgt}$ indicates the percentage of students taught by a specialist in math or reading in a school grade, by year. When examining non-test score outcomes, we use the percentage of students taught by either math or reading specialists. $School_{sgt}$ indicates time-varying school-grade level characteristics, including the percentage of teachers who have a graduate degree, the percentage of teachers who are new to the school, school size, the percentage of students who are Black and Hispanic, and the percentage of students who are eligible for free or reduced lunch prices. δ_s is a school fixed effect that controls for time-invariant school characteristics, θ_g is a grade fixed effect, ρ_t is a year fixed effect and ϵ_{sgt} is an error term. To examine potential heterogeneous effects of teacher specialization, we also include interaction terms between the percentage of students who study with specialists and school characteristics, including FRL rates, the percentage of Black and Hispanic students, and prior-year student achievement.

Results

Descriptive Characteristics

We first examine school characteristics and how they relate to the prevalence of teacher specialization across quartiles of the percentage of students with subject area specialists. Overall, we find few differences across schools with more or less teacher specialization (Table 2). Schools with high and low specialization are similar in terms of percent Black, percent Hispanic, percent FRL, prior achievement, and school size. In addition, teacher specialization does not vary much by school urbanicity.

Next, we investigate teacher characteristics that predict specialization in math or reading. Perhaps counterintuitively, Table 3 shows that teachers with lower lagged value-added scores and those categorized by the IDOE as not highly qualified are more likely to become subject-area specialists, compared with generalist teachers within a school during the same school years. Column 1 in Table 3 shows that one *SD* increase in lagged math value-added score is associated with a 4.8 percentage point decrease in the probability of becoming a math specialist. In addition, being designated a highly qualified teacher is associated with 10.7 percentage point decrease in the probability of becoming a math specialist. Hispanic teachers and more experienced teachers are also less likely to become math specialists. Column 2 shows the results from models that predict becoming reading specialists, and the findings are substantively similar.

Teacher Specialization and Teaching Effectiveness

Our primary results regarding the impacts on teaching effectiveness of subject-area specialization are shown in Table 4. Column 1 in Table 4 shows that when a teacher specializes in fewer

TABLE 2

School Characteristics Across Levels of Teacher Specialization

Characteristic	Specialization Quartile 1 (<3.6%)	Specialization Quartile 2 (3.6%~26.3%)	Specialization Quartile 3 (26.3~53.7%)	Specialization Quartile 4 (53.7%~100%)
% Black	7.17	4.54	5.69	7.73
% Hispanic	6.65	4.66	5.63	6.13
% FRL	26.97	25.23	27.14	30.77
School enrollment	403.99	416.82	413.81	458.48
Prior year school-level achievement	−0.04	−0.01	−0.01	−0.05
Rural	0.28	0.39	0.34	0.32
City	0.39	0.19	0.29	0.33
Town	0.10	0.15	0.16	0.14
Suburb	0.22	0.27	0.21	0.20
N (school-year cases)	2,170	2,170	2,170	2,170

Note. Results are based on school-year level data in Indiana from 2010–2011 to 2016–2017. FRL = free or reduced-price lunch eligibility. Specialization indicates the percentage of teachers who teach only one or two subjects in a given school year.

TABLE 3

Characteristics of First-Time Specialists

	First-time math specialist	First-time reading specialist
Characteristic	(1)	(2)
Prior value-added score	−0.048*	−0.022
	(0.019)	(0.032)
Highly qualified designation	−0.107***	−0.036**
	(0.014)	(0.012)
Female teacher	0.008	0.011
	(0.008)	(0.008)
Black teacher (ref. White teacher)	0.004	0.018
	(0.015)	(0.023)
Hispanic teacher	−0.042**	0.028
	(0.016)	(0.033)
Other race/ethnicity teacher	0.092	0.031
	(0.102)	(0.037)
Years of teaching experience	−0.002***	−0.003***
	(0.000)	(0.000)
Graduate degree	0.000	0.006
	(0.007)	(0.008)
Constant	0.213***	0.220***
	(0.014)	(0.014)
School FE	X	X
Year FE	X	X
N (teacher-year cases)	32,453	37,023

Note. Results are based on teacher-year data from 2011–2012 to 2016–2017 academic years (we necessarily exclude the first year of data, 2010–2011). Highly qualified teacher designation in Indiana indicates teachers who are qualified in the subject via (a) passing PRAXIS/NTE, (b) 24 credits/degree in core academic, or (c) national board certification. Standard errors in parentheses are clustered at the school level. FE = fixed effect.

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

TABLE 4

Teacher Specialization and Teaching Effectiveness in Math and Reading

	Math		Reading	
	(1)	(2)	(3)	(4)
Characteristic	Model 1	Model 2	Model 1	Model 2
Specialization	−0.041***		−0.013**	
	(0.006)		(0.004)	
First year of specialization		−0.048***		−0.018***
		(0.007)		(0.004)
Second year of specialization		−0.031***		−0.002
		(0.008)		(0.004)
Three years+ specialization		−0.035***		−0.006
		(0.009)		(0.005)
Teacher fixed effects	X	X	X	X
N (student-year cases)	1,789,158	1,789,158	1,783,212	1,783,212

Note. All models include teacher, school, grade, and year fixed effects. In addition, we control for student level prior achievement, gender, race/ethnicity, FRL, ELL, IEP, and class size, teacher time-varying characteristics including graduate degree, being new to the school, years of teaching, and highly qualified designation, and school-level achievement, percent Black, percent Hispanic, percent FRL, and school enrollment. Standard errors in parentheses are clustered at the school level. ELL = English language learners; FRL = free or reduced-price lunch; IEP = individualized education program.
*$p < .05$. **$p < .01$. ***$p < .001$.

subjects, their teaching effectiveness in math is 0.041 *SD* lower compared with when that same teacher is a generalist. Column 2 shows that the first year of specialization generates the largest negative impact, at −0.048 *SD*, whereas the second and subsequent years of specialization lead to −0.031 *SD* and −0.035 *SD* decreases in math teaching effectiveness, respectively. Although the estimates are less pronounced in reading, the patterns are similar. On average, when a teacher teaches fewer subjects to more students, their average effectiveness in reading is 0.013 *SD* lower. This is largely driven by a −0.018 *SD* effect in the first year of specialization. Effects in reading effectiveness in subsequent years are not statistically significant.

We report the results from our falsification tests in Appendix Table 5 (available in the online version of this article). When we estimate separate parameters for the actual and placebo teacher and student assignments in separate regressions, the placebo estimates are statistically indistinguishable from zero. This indicates that assignment to treatment is not based on the time-varying performance of teachers or students prior to being assigned to specialization and further supports our identification strategy.

We next test for effect heterogeneity by including interaction terms between specialization and subgroup indicators (Table 5). Because we use teacher fixed effects, our estimations indicate whether the within-teacher change in teaching effectiveness has a greater impact for certain groups of students, conditional on fixed teacher attributes. The reduction in teaching effectiveness is greater for students from historically underserved populations. For math achievement, racial/ethnic minority students with specialists experience a greater decrease than White students with specialists. Specifically, the negative effects of teacher specialists on math achievement are larger for Black, Hispanic, and other race/ethnicity by 0.25 *SD*, 0.17 *SD*, 0.11 *SD*, respectively. Although FRL students with specialists experience a 0.048 *SD* decrease, non-FRL students experience a 0.036 *SD* decrease. Similarly, ELL students with specialists experience a 0.053 *SD* decrease in test scores, compared with a 0.041 *SD* decrease for non-ELL students. The negative impact is also greater for

TABLE 5

Specialization and Student Achievement Across Student Subgroups

	Math					Reading				
Characteristic	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Teacher specialization	−0.037**	−0.036***	−0.041***	−0.038***	0.022**	−0.011**	−0.006	−0.014***	−0.010**	−0.012
	(0.006)	(0.006)	(0.006)	(0.006)	(0.008)	(0.004)	(0.004)	(0.004)	(0.004)	(0.007)
Black (ref.: White)	−0.074***					−0.075***				
	(0.004)					(0.004)				
Hispanic	−0.014***					−0.007*				
	(0.003)					(0.003)				
Other race/ethnicity	0.026***					0.029***				
	(0.004)					(0.004)				
FRL		−0.081***	−0.088***	−0.088***	−0.108***		−0.093***	−0.102***	−0.102***	−0.122***
		(0.002)	(0.001)	(0.001)	(0.001)		(0.002)	(0.001)	(0.001)	(0.002)
ELL		−0.025***	−0.018***	−0.025***	−0.067***		−0.058***	−0.067***	−0.058***	−0.094***
		(0.003)	(0.004)	(0.003)	(0.004)		(0.003)	(0.004)	(0.003)	(0.004)
IEP		−0.127***	−0.127***	−0.113***	−0.198***		−0.207***	−0.207***	−0.196***	−0.312***
		(0.002)	(0.002)	(0.003)	(0.003)		(0.002)	(0.002)	(0.003)	(0.003)
Achievement Q1 (ref.: Q4)					−1.762***					−1.682***
					(0.006)					(0.005)
Achievement Q2					−1.115***					−1.091***
					(0.004)					(0.004)
Achievement Q3					−0.643***					−0.604***
					(0.003)					(0.004)
Prior achievement (Math or ELA)		0.752***	0.752***	0.752***			0.704***	0.704***	0.704***	
		(0.002)	(0.002)	(0.002)			(0.001)	(0.001)	(0.001)	
Specialization × Black	−0.025***					−0.019***				
	(0.005)					(0.005)				
Specialization × Hispanic	−0.017***					−0.001				
	(0.004)					(0.004)				
Specialization × Other race/ethnicity	−0.011*					−0.011*				
	(0.005)					(0.005)				

(continued)

TABLE 5. (CONTINUED)

	Math					Reading				
Characteristic	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Specialization × FRL		−0.012***					−0.014***			
		(0.003)					(0.003)			
Specialization × ELL			−0.012**					0.015***		
			(0.005)					(0.005)		
Specialization × IEP				−0.024***					−0.019***	
				(0.004)					(0.004)	
Specialization × Achievement Q1					−0.082***					0.001
					(0.008)					(0.007)
Specialization × Achievement Q2					−0.091***					0.004
					(0.006)					(0.006)
Specialization × Achievement Q3					−0.062***					−0.014***
					(0.006)					(0.005)
Teacher Fixed effects	X	X	X	X	X	X	X	X	X	X
N (student-year cases)	1,789,158	1,789,158	1,789,158	1,789,158	1,789,158	1,783,212	1,783,212	1,783,212	1,783,212	1,783,212

Note. All models include teacher, school, grade, and year fixed effects. In addition, we control for student level prior achievement, gender, race/ethnicity, FRL, ELL, IEP, and class size, teacher time-varying characteristics including graduate degree, being new to the school, years of teaching, and highly qualified designation, and school-level achievement, percentage of Black, percentage of Hispanic, percentage of FRL, and school enrollment. Standard errors in parentheses are clustered at the school level. FRL = free or reduced-price lunch eligibility; ELL = English language learners; IEP = individualized education programs.
$^*p < .05$. $^{**}p < .01$. $^{***}p < .001$.

TABLE 6

Teacher Specialization and School-Level Achievement Across School Characteristics

	School-level math achievement				School-level reading achievement			
Characteristic	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
% Specialization	−0.013	−0.028	−0.024	0.010	−0.008	−0.013	−0.004	−0.001
	(0.013)	(0.029)	(0.015)	(0.014)	(0.010)	(0.018)	(0.011)	(0.011)
% Specialization × % FRL		0.000				0.000		
		(0.001)				(0.001)		
% Specialization × % Black and Hispanic			−0.000				−0.000	
			(0.000)				(0.000)	
% Specialization × Prior Achievement				−0.036				−0.004*
				(0.028)				(0.018)
Constant	0.112**	0.119**	0.111**	0.155***	0.103***	0.100***	0.097***	0.103**
	(0.036)	(0.036)	(0.036)	(0.045)	(0.028)	(0.029)	(0.028)	(0.036)
N (school-grade-year cases)	16,082	16,082	16,082	13,829	16,076	16,076	16,076	13,824

Note. All models include school fixed effects and controls for percentage of FRL, percentage of Black and Hispanic students, school size, percentage of teachers who are new to school, and percentage of teachers with a graduate degree. Standard errors in parentheses are clustered at the school level. FRL = free or reduced-price lunch eligibility.
**p* < .05. ***p* < .01. ****p* < .001.

students with IEPs, who experience a 0.062 *SD* decrease in math achievement. In addition, we show that specialization tends to have larger negative effects for students who were lower achieving in the previous year.

Columns 6 through 10 show that the negative effects of specialization in reading tend to be greater for underserved student populations and for students who may face more obstacles at school. For example, minority students with specialists experience a greater decrease in reading scores relative to White students. In addition, FRL students, IEP students, and lower-achieving students experience greater reductions in reading achievement. However, non-ELL students exhibit greater reductions in reading achievement than ELL students. One possible explanation is that ELL students may have unique reading-instruction needs such that they may benefit from a specialist mode of instruction.

Teacher Specialization and School Improvement

Finally, we examine the aggregate effect of teacher specialization in schools. Table 6 shows whether the percentage of subject-area teacher specialization affects grade-level math or reading achievement. Columns 1 and 5 indicate that math teacher specialization rates are not associated with school-level math or reading achievement. Columns 2 through 4 show the results from models with interactions between math teacher specialization and school characteristics indicating proportions of students in poverty, minority students, and prior achievement levels. We find no evidence of heterogeneous effects between math specialization across these school characteristics. In terms of school-level reading performance, we find consistent results that specialization effects do not vary by proportions of students in poverty and the percentage of Black and Hispanic students (Columns 6 and 7 in Table 6). We find some suggestive evidence that reading specialization negatively affects reading achievement at more high-achieving schools, though the effect is small.

We further test whether teacher specialization affects school-level behavioral outcomes, specifically absences or school disciplinary outcomes (Table 7). We find no evidence that the

TABLE 7

Teacher Specialization and School-Level Absence and Discipline Across School Characteristics

	School absences				School discipline			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
% Specialization	0.086	−0.047	0.003	0.008	−0.003	−0.000	−0.000	−0.005
	(0.059)	(0.170)	(0.048)	(0.069)	(0.002)	(0.005)	(0.002)	(0.003)
% Specialization × % FRL		−0.001				−0.000		
		(0.007)				(0.000)		
% Specialization × % Black and Hispanic			−0.004				0.000	
			(0.003)				(0.000)	
% Specialization × Prior Achievement				−0.154				−0.010
				(0.243)				(0.009)
Constant	1.173***	1.162***	1.145***	1.074**	0.043***	0.042***	0.043***	0.051*
	(0.283)	(0.289)	(0.287)	(0.386)	(0.011)	(0.011)	(0.011)	(0.014)
N (school-grade-year cases)	16,076	16,076	16,076	13,824	16,076	16,076	16,076	13,824

Note. All models include school fixed effects and controls for percentage of FRL, percentage of Black and Hispanic students, school size, percentage of teachers who are new to school, and percentage of teachers with a graduate degree. Standard errors in parentheses are clustered at the school level. FRL = free or reduced-price lunch eligibility.
**p* < .05. ***p* < .01. ****p* < .001.

percentage of a school's teacher specialization affects these behavioral student outcomes.[2] In addition, there are no heterogeneous effects across different school characteristics, including school percent FRL, percent Black and Hispanic students, and prior school-level achievement. As a robustness check, we present results using school-year level data instead of school-grade-year level data in Appendix Tables 6 and 7 (available in the online version of this article), and the results are consistent.

Discussion and Conclusion

We use 7 years of administrative data on elementary school students and teachers to investigate whether and the extent to which subject-area specialization affects teaching effectiveness and school performance. Although specialization is conceptually alluring because it can capitalize on teachers' comparative advantages and streamlines their preparation and training, it does not seem to benefit students. Our teacher fixed-effect models show that teaching effectiveness in math and reading decreases when teachers teach fewer subjects to more students. We further show that the negative effects have a greater impact for students who tend to experience more obstacles in school, including racial/ethnic minorities, FRL eligible students, students with IEPs, lower-achieving students, and ELL students (in math). This is consistent with related evidence showing that relationships are especially important for underserved students (Al-Yagon & Mikulincer, 2004; Baker, 1999; O'Connor & McCartney, 2007; Wu et al., 2010). At the school level, the relative concentration of teacher specialization does not translate into increased school-level outcomes, including average achievement, absences, or school disciplinary incidents.

It is possible that specialization fails to live up to its promise because school leaders are not able to effectively determine which teachers should specialize in which subjects. We show that teachers who exhibit lower value-added scores and are not designated as highly qualified tend to become specialists in Indiana. Yet, related work in North Carolina found higher-quality teachers (based on value-added score and principal evaluation) tend to become specialists, but otherwise had similar findings to ours (Bastian & Fortner, 2020). In both cases, subject area specialization reduced teaching effectiveness, and there is no evidence that increasing the number of specialists improves school performance.

One mechanism that may explain our findings is that specialization weakens student–teacher relationships. To explore this theory further, we investigate whether the negative effects of specialization are reduced if students are assigned to the same specialist for two consecutive years (i.e., repeating student–teacher matching). We find that the negative effects of specialization in math achievement are somewhat abated when students are taught by the same specialist in a consecutive year (Appendix Table 8, available in the online version of this article). Although the results are suggestive, they show that finding strategies to increase student–teacher familiarity with specialists may improve their effectiveness (Hill & Jones, 2018; Hwang et al., 2021).

This study contributes to our understanding of elementary school teacher specialization, but it has limitations. First, because our identification strategy relies on teacher fixed effects, we are not able to estimate teacher effectiveness for teachers who are either specialists or generalists all the time during the study period. Although teacher fixed effects remove time-invariant characteristics and provide a reliable method to identify the effect on switchers, teachers who are always specialists and generalists do not contribute to our estimations. In addition, our school-level models cannot fully capture the complexity of decision-making that goes into assigning teachers to specialist roles. Although the aggregate effect of increased specialization appears to be null, we do not directly observe a counterfactual scenario where a school opts not to specialize with every other aspect within the school held constant. It is possible, for example, that schools increase specialization as a strategy to deal with a shortage of qualified teachers, and without increased specialization school performance may actually decrease.

Despite these limitations, our findings provide useful insight into elementary school teacher specialization and echo the findings of related research on specialization and the importance of teacher relationships (Bastian & Fortner, 2020; Fryer, 2018). Indeed, teachers randomly assigned to specialized roles reported being less likely to provide tailored instruction for their students and demonstrated a negative impact on self-reported job performance (Fryer, 2018). Our findings further underscore the importance of developing strong student–teacher relationships (Grant et al., 1996; Hill & Jones, 2018; Hwang et al., 2021). Future research should explore the possible mechanisms underlying the negative effects of specialization. In particular, estimating the effects of specialization on measures of school climate indices and other student social and emotional learning outcomes may shed light on the specific mechanisms that contribute to the negative effects of specialization. With additional study, educators may be able to identify optimal ways to harness the potential gains of specialization without the unintended consequences that teacher specialization seems to generate.

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Notes

1. One limitation of our teacher fixed-effects approach is that teachers who are always specialists or generalists do not contribute to our estimations, which may raise concerns regarding the external validity of our estimates. In Appendix Table 2 (available in the online version of this article), we show that 12% of math teachers and 37% of reading teachers are switchers (i.e., sometimes specialists). Switchers are slightly more likely to be White, have lower value-added scores, have more years of experience, and have graduate degrees, albeit these differences are small.

2. Because discipline could be inconsistently enforced or recorded across schools or within schools, we also examine the effect of teacher specialization rates on major infractions, which arguably are enforced with less discretion. Major infractions include alcohol, drugs, deadly weapons, handguns, rifles or shotguns, other firearms, fighting, intimidation, and tobacco. Our results are similar when using this restriction.

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