



Subject-Area Specialization in North Carolina Elementary Schools

In this research brief, we assess whether subject-area specialization is leading to its theorized benefits in elementary schools. Descriptively, we find that subject-area specialization is already common in upper elementary grades in North Carolina. Empirically, we find that (1) schools assign more effective teachers to specialize; (2) teachers are less effective, in mathematics and reading, after becoming subject-area specialists; (3) specialization is related to improvements in school-level science achievement; and (4) teachers are more likely to return to the same school after becoming a specialist. While subject-area specialization is not yet leading to its theorized benefits in mathematics and reading, these results suggest that specialization may be a net positive for elementary schools. More research is needed to replicate and extend these analyses.

Introduction

Many schools are searching for low-cost innovations to boost teacher effectiveness and retention. Towards these ends, subject-area specialization stands out as a potentially promising practice to benefit elementary school teachers and students. Rather than teaching all four academic content areas in a self-contained classroom, specialization means teaching a subset of subject-areas. Schools can use existing performance data to assign teachers to the subject-areas in which they are more effective. This strategic assignment practice may improve student achievement by helping teachers acquire more subject-specific knowledge and skills and by connecting teachers who are highly-effective in a particular subject-area to more students. Furthermore, subject-area specialization may improve teacher retention by increasing teachers' self-efficacy and job satisfaction.

While subject-area specialization is a common practice in middle and high schools, little is known about its incidence and impact in elementary schools. In this research brief, we document the prevalence of specialization in North Carolina elementary schools, describe the teachers who

specialize, and assess the impact of specialization on teacher effectiveness, school achievement, and teacher retention. These answers can help North Carolina elementary schools make evidence-based decisions about specialization.

Background

Our analyses focus on content-area teachers (i.e. mathematics, reading, science, and social studies) in grades K-5 in North Carolina public schools in the 2011-12 through 2015-16 school years. In particular, many of our analyses focus on teachers in grades 4-5, as these are the grade levels at which we can assess value-added to student achievement. These are also grade levels in which school leaders may be more strategic in their teacher assignment practices due to school accountability pressure. Overall, our sample includes 55,000 unique teachers in grades K-5 and 23,500 unique teachers in grades 4-5.

We use classroom roster data from the North Carolina Department of Public Instruction to identify subject-area specialists. Specifically, we use state course codes to count the unique number of academic subject-areas—

mathematics, reading, science, and social studies—taught by a teacher in a given year. We define generalists as those teaching three or four subject-areas and specialists as those teaching one or two subject-areas. Beyond these broad categories, we created an indicator for teaching one subject-area only, an indicator for teaching two subject-areas, and a set of indicators for the specific subject-area combinations in which teachers specialized (e.g. mathematics only, reading and social studies).

To date, only one study has examined the impact of subject-area specialization on student achievement. In a randomized experiment in Houston, Fryer (2018) found that specialization had a negative impact on elementary school student achievement. While experiments provide rigorous evidence, there are concerns about the generalizability of these findings (i.e. would the findings hold in other settings). Furthermore, there are other questions to answer about subject-area specialization. Our work addresses these points with a comprehensive, statewide study of elementary school specialization.

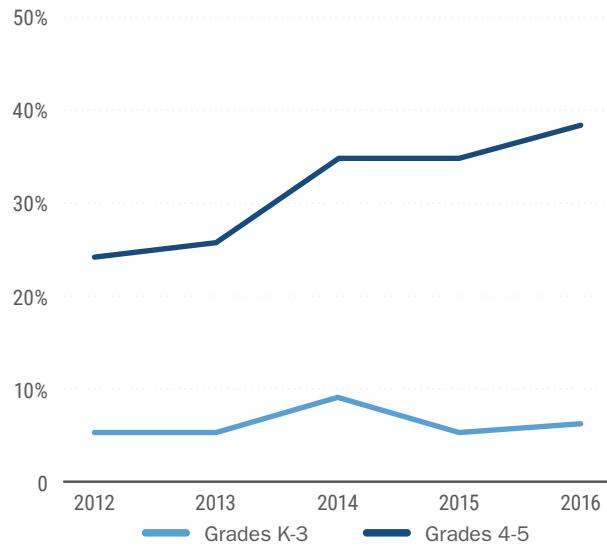
What is the Prevalence of Subject-Area Specialization in Elementary Grades?

Figure 1 displays trends in the percentage of subject-area specialists in grades K-3 and in grades 4-5 during the 2011-12 through 2015-16 school years. Overall, specialization is rare in early elementary grades—approximately five to seven percent of K-3 teachers specialize. Conversely, subject-area specialization is more common in upper elementary grades and has become an increasingly used assignment practice during our study period. In 2012, approximately 25 percent of upper elementary grades teachers specialized, by 2016, nearly 40 percent of 4th and 5th grade teachers were subject-area specialists.

To better understand the increased use of specialization in upper elementary grades, Figure 2 presents trends in the percentage of teachers specializing in select subject-area combinations. During our study period, there have been substantial increases in the percentage of two-subject specialists in reading and social studies and in mathematics and science. For example, the percentage of 4th and 5th grade teachers specializing in reading and social studies increased from five to 11 percent between 2012 and 2016. Likewise, the percentage of upper elementary grades teachers specializing in mathematics and science increased

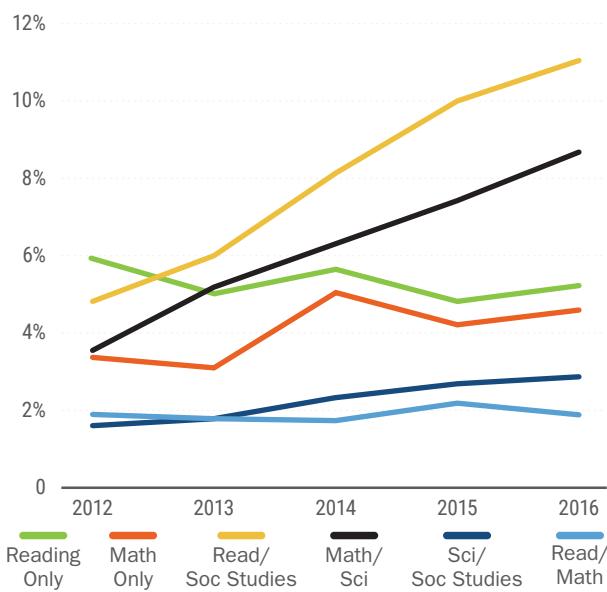
from 3.5 to 8.5 percent. These data suggest that school leaders may be pairing upper elementary grades teachers together—i.e. assigning one teacher to two subject-areas and another teacher to the remaining two subject-areas.

Figure 1: The Percentage of Subject-Area Specialists by Grade Band, 2012 to 2016



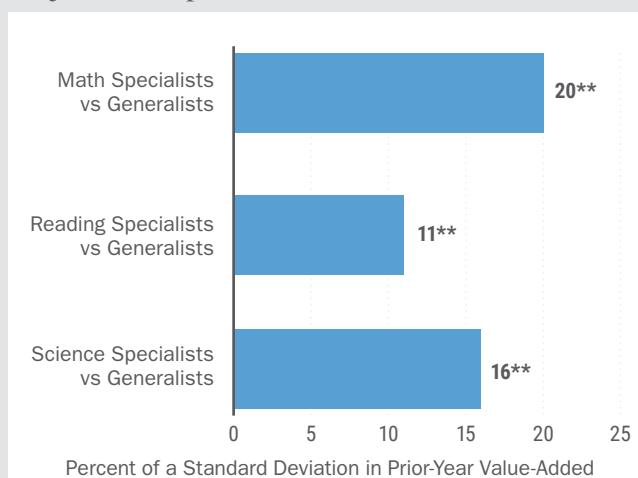
Note: This figure displays the percentage of teachers in grades K-3 and in grades 4-5 who are subject-area specialists during the 2011-12 through 2015-16 school years.

Figure 2: The Percentage of Subject-Area Specialists in Select Categories (Grades 4-5)



Note: This figure displays the percentage of upper elementary grades teachers (4-5) specializing in select subject-area combinations over the 2011-12 through 2015-16 school years.

Figure 3: Prior-Year Teacher Effectiveness and Subject-Area Specialization



mathematics. First-time reading specialists have lagged value-added estimates 11 percent of a standard deviation higher in reading and first-time science specialists have lagged value-added estimates 16 percent of a standard deviation higher in science. This indicates that schools assign relatively more effective teachers to specialize. Other results (not shown) indicate that teachers with higher prior-year evaluation ratings on North Carolina's Facilitating Student Learning standard are more likely to specialize in reading for the first time. More experienced teachers are more likely to be first-time specialists in mathematics. Finally, female teachers are more likely to be first-time specialists in reading and less likely to be first-time specialists in mathematics and science.²

Are Teachers More Effective After Becoming a Specialist?

Theory suggests that teachers will be more effective after becoming subject-area specialists.³ To test this, we estimated value-added models with a teacher fixed effect. This allows us to compare teacher effectiveness pre and post-specialization.

Figure 4 shows that teachers are less effective in mathematics and reading after becoming subject-area specialists. For example, students taught by a math specialist have adjusted-average achievement four percent of a standard deviation lower than students taught by the same teacher when she was a generalist. These negative results are larger in magnitude—more than double the size—for those teaching mathematics or reading only versus those specializing in two subject-areas. Further analyses show that these negative effects persist in mathematics. Even after specializing for multiple years, mathematics specialists are less effective than in years when they worked as a generalist. One explanation for these negative results may be inefficient pedagogy. That is, because specialists teach more students in a given year,⁴ they may have fewer interactions with and provide

Which Elementary Grades Teachers Specialize?

In order for specialization to promote student achievement, schools need to ensure that more effective mathematics, reading, and science teachers specialize in those subject-areas.¹ With this motivation, we estimated models to determine whether measures of prior teacher performance, teacher credentials, and teacher demographics predict teachers specializing for the first time. In these models we include a school-by-year fixed effect. This allows us to compare the specialization status of teachers working in the same schools.

Relative to generalists within the same schools, Figure 3 shows that *first-time* specialists have significantly higher prior-year value-added estimates. Specifically, first-time mathematics specialists have lagged value-added estimates 20 percent of a standard deviation higher in

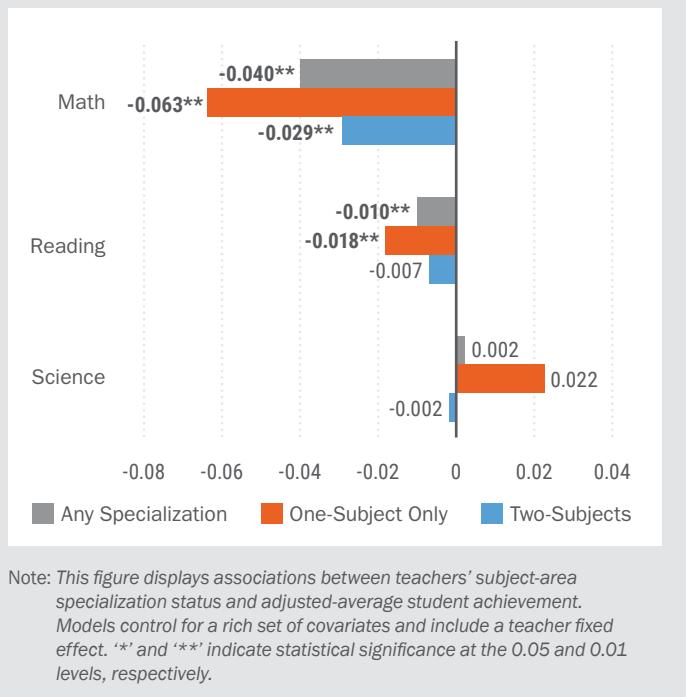
¹ This is also true for social studies. However, measures of teacher effectiveness in social studies are not available for all the years of our analyses.

² We also examined the characteristics of the schools in which specialists and generalists work. School characteristics are similar for both groups with one exception—specialists are more likely to work in rural environments.

³ Specialists may engage in more targeted professional development and have more opportunities to enhance their knowledge and instructional skills in specific content areas.

⁴ In our analytic sample, generalists taught an average of 27 unique students during the year. By comparison, those teaching mathematics only taught an average of 58 unique students while those teaching mathematics and one other subject taught an average of 45 unique students.

Figure 4: Does Subject-Area Specialization Increase Teacher Effectiveness?



less individualized attention to each student. Additional models support this as a potential explanation—teachers are less effective in mathematics and reading when they teach more students.

Specialization results for science differ from those in mathematics and reading. On average, science specialists are no more or less effective than they were as generalists. Further evidence suggests that science teachers become more effective with experience as a specialist. We cannot definitively ascertain why results are different in science versus mathematics and reading. However, evidence suggests that there may be unique aspects of science—i.e. content, curricula, pedagogical techniques—that are not adversely influenced by specialization.

Does Subject-Area Specialization Benefit School Achievement?

Given the evidence presented in the previous sections, it is unclear whether higher concentrations of specialization will have a positive or negative effect on school achievement. On one hand, principals assign more effective teachers to specialize. This should benefit school achievement. On the other hand, teachers are less effective (in mathematics and reading) after becoming a subject-area specialist. This may negate any school-level benefits of specialization. To address this, we aggregated student achievement in mathematics, reading, and science to the school-by-year level. With these data we estimated models to assess how changes in the intensity⁵ of specialization predict changes in school achievement.

Results in Table 1 indicate that school achievement in mathematics and reading is unchanged when more students are taught by a subject-area specialist. This suggests that the adverse effects of specialization for individual teachers are balanced by assigning more effective teachers to specialize. For 5th grade science, more specialization predicts higher school-level achievement. Specifically, a one standard deviation increase in the percentage of students taught by a science specialist is associated with a two percent of a standard deviation increase in aggregate science achievement.

Are Subject-Area Specialists More Likely to Return to the Same School?

Subject-area specialization may represent a non-pecuniary incentive that increases teachers' self-efficacy, job-satisfaction, and desire to remain at the same school. To test this, we made returning to the same school our

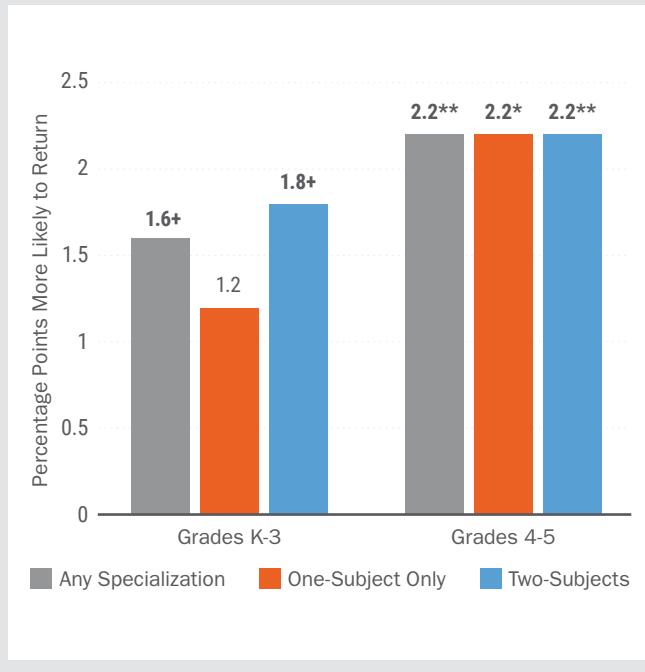
Table 1: Does Subject-Area Specialization Benefit School Achievement?

	Aggregated Mathematics Achievement	Aggregated Reading Achievement	Aggregated Science Achievement
Percentage of Students Taught by a Specialist (Standardized)	-0.002	-0.000	0.020**

Note: This table displays results from models examining the associations between aggregated achievement (at the school-grade-subject-year level) and the intensity of subject-area specialization. Models control for school characteristics and include a school fixed effect. ** and *** indicate statistical significance at the 0.05 and 0.01 levels, respectively.

⁵ We define the intensity of specialization as the percentage of students, by grade, school, subject, and year, taught by a subject-area specialist. We standardize this measure for analyses. These analyses include a school fixed effect.

Figure 5: Are Subject-Area Specialists More Likely to Return to the Same School?



Note: This figure displays associations between teachers' subject-area specialization status and the likelihood of returning to teach in the same school in the following year. Models control for teacher, classroom, and school characteristics and include a teacher fixed effect. '+', '*' and '**' indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively.

outcome measure and estimated models controlling for teacher, classroom, and school characteristics. These models included a teacher fixed effect, which allows us to compare teacher retention pre and post-specialization.

Figure 5 illustrates that subject-area specialists are more likely to return to the same school. Relative to their retention outcomes as generalists, we find that upper elementary grades teachers (4-5) are 2.2 percentage points more likely to return to the same school after becoming a specialist. Results in grades K-3 are smaller in magnitude but still statistically significant (for any specialization and two-subject specialization). To put these estimates into perspective, we note that during our study period approximately 82 percent of K-5 teachers returned to the same school in the following year. These results suggest that subject-area specialization may be an effective, low-cost approach to retain teachers.

Discussion

This research is motivated by the theoretical promise of subject-area specialization. Specialization represents a low-cost approach for schools to (1) boost teacher effectiveness, by providing opportunities to acquire more subject-specific knowledge and skills; (2) increase student achievement, by assigning more students to the classrooms of effective teachers; and (3) retain more teachers, by promoting teachers' job satisfaction. We evaluated each of these claims and have four key takeaways from our analyses.

First, subject-area specialization is already prevalent in upper elementary grades in North Carolina. By 2016, nearly 40 percent of 4th and 5th grade teachers were specialists. This prevalence enhances the practical significance of our achievement and retention results. Second, schools already assign relatively more effective teachers to specialize in mathematics, reading, and science. This suggests that schools have the capacity to leverage data for strategic teacher assignments.

Third, subject-area specialization is not yet leading to its hypothesized benefits in mathematics and reading. In particular, mathematics and reading teachers are less effective as specialists than they were as generalists. While it is unclear why specialists become less effective, one credible explanation is inefficient pedagogy. Relative to generalists in self-contained classrooms, specialists may have less time and fewer interactions with students. This means that specialists may be less able to meet particular student needs and less able to integrate and reinforce academic content throughout the day. More broadly, these results hint at the importance of teacher-student relationships.

Finally, despite the negative results for individual teacher effectiveness, we find that specialization may be a net positive for schools. In science, more specialization boosts school achievement. In mathematics and reading, more specialization is unrelated to school achievement. Teachers are also more likely to return to the same school after becoming a subject-area specialist. This may benefit school stability and teacher collaboration and suggests that teachers value the opportunity to specialize. Moving forward, research should continue to assess specialization and its impacts on teachers, students, and schools.

For More Research on this Topic

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