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Teacher Preparation, Classroom Structure, and Learning Outcomes for Students with Disabilities

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Abstract

Ample research investigates returns to teacher preparation and other instructional inputs for the general student population, yet evidence is lacking for students with disabilities (SWDs). This study uses North Carolina data to estimate achievement returns to teacher preparation by classroom type and level of classroom support for SWDs. I find that SWDs perform better when placed in inclusive classrooms and when these classrooms have co-teachers. Regardless of classroom type, SWDs benefit from more experienced teachers, but only gain from special education certified teachers in certain classroom configurations. These results indicate that education leaders can optimize resource allocation by minimizing separate classrooms for SWDs, relaxing special education certification requirements, and investing in an experienced teacher workforce with support from co-teachers.

Introduction

Students with disabilities (SWDs) in U.S. public schools perform more than three years below their peers without identified disabilities (Gilmour et al., 2019). Achievement disparities persist across all main subjects and grade levels (U.S. Department of Education [USDOE], 2022). As the most important input in the education production function, teacher effectiveness – commonly proxied by teacher preparation measures including experience, education, and licensure – is central to any attempts for identifying educational inputs that can help improve outputs, namely achievement, for SWDs. Although the determinants of teacher effectiveness in terms of teachers' impact on student achievement have been extensively studied in the general education context (Boyd et al., 2009; Buddin & Zamarro, 2009; Clotfelter et al., 2007; Harris & Sass, 2011), such evidence is limited for SWDs (Feng & Sass, 2013; Gage et al., 2017; Gilmour, 2020; Theobald et al., 2022).

Moreover, schools and districts across the U.S. have been facing severe special education teacher shortages for decades (Sutcher et al., 2016). In the 2015-16 school year, special education teacher shortages were reported in 48 states and District of Columbia, making special education the subject area with the most reported teacher shortages (Sucher et al., 2016). The constant struggle to fill special education teacher vacancies with qualified teachers have led many states to consider accelerated or alternative pathways to teaching for special education teachers, which, on average, would reduce teacher qualifications. Given the crucial role that teacher effectiveness plays in determining student achievement (Goldhaber, 2016), hiring special education teachers with less training and fewer credentials may have detrimental effects on achievement for SWDs. In a vacuum of information on the determinants of teacher effectiveness in the context of special education, identifying the aspects of teacher qualifications that matter

for SWDs' learning is important for informing strategies on how to best allocate resources to address special education teacher shortages and minimize achievement disparities between SWDs and their peers without disabilities.

In addition to and in concert with teacher effectiveness, other school inputs that may influence academic achievement include classroom placement and instructional approach. Research on classroom placement generally reaches a consensus that SWDs benefit from greater inclusion in general education as opposed to self-contained special education settings (Hehir et al., 2014; Rojewski et al., 2015; Theobald et al., 2019; Justice et al., 2014; Flexer et al., 2011; Anderson, 2021). However, this research seldom identifies specific instructional practices within inclusive classrooms that SWDs benefit from. For example, co-teaching – an inclusive classroom teaching approach that involves both general and special education teachers working together to instruct SWDs and students without identified disabilities – has been overlooked by research on inclusion effectiveness (Jones & Winters, 2022). This practice has received considerable support in research and practice due to its potential benefits for SWDs, resulting from simultaneous access to both general education curriculum and specially developed instruction (Friend et al., 2015). However, limited evidence exists on both the prevalence of co-teaching and its effectiveness, despite the potential implications for optimizing the use of scarce special education certified teachers.

Since SWDs may receive instruction in either inclusive or self-contained classrooms and be concurrently exposed to multiple teachers, a thorough examination of the aspects of teacher preparation that impact SWDs' academic progress requires considering how teacher qualifications interact with classroom type and instructional approach. To my knowledge, only one study by Feng and Sass (2013) has examined how teacher effectiveness for SWDs differed

based on classroom placement, but no research has so far examined how the effectiveness of the main classroom teacher is influenced by the presence of co-teachers within their classroom.

This study estimates returns to teacher preparation (licensure, education, experience) for SWDs and, in doing so, speaks to policy debates about how to best address special education teacher shortages and minimize achievement disparities between SWDs and their peers without disabilities. I also investigate how teacher preparation effects differ based on whether the student is placed in inclusive cotaught, inclusive non-cotaught, or self-contained classrooms. I use a student fixed effects approach with linked student, classroom, and teacher data from North Carolina from the 2006-07 to 2013-14 school years to estimate the effects of teacher credentials on achievement for SWDs in grades three to eight. I focus on the following teacher credentials: special education licensure, general education licensure, dual licensure in special education and general education, lateral entry or provisional licensure, advanced degree attainment, and years of experience.

In line with previous research, my findings indicate that, in general, SWDs in inclusive classrooms perform better in math and reading than in self-contained classrooms. The benefits of inclusive classroom placement are larger in secondary, as opposed to elementary grades. I also find that students placed in inclusive classrooms tend to perform slightly better when such classrooms have co-teachers. The positive, but relatively small effects of co-teaching are primarily driven by students in elementary grades.

The findings also surprisingly show that, overall, students whose teachers have a special education license do not perform any better in either ELA (English Language Arts) or math than students whose teachers are general education certified. Students benefit from special education

certified teachers only when placed in self-contained ELA classrooms and inclusive co-taught math classrooms.

Lastly, teacher experience is positively associated with student achievement in both math and reading, and the positive returns to teacher experience extend beyond the first few years of teaching. Sub-analyses by disability category reveal that the impact of teacher experience varies by disability type, with students with learning disabilities and speech impairments benefiting the most from experienced teachers.

In the remainder of this paper, I first present a review of the literature on the role of teacher preparation and classroom placement and instructional approach on student outcomes and discuss this study's contribution to existing literature. I then introduce the data and empirical models. Then, I describe the patterns of both student and teacher sorting across different types of classrooms. Finally, I present the results and discuss the implications for policies and practices regarding self-contained classrooms and the recruitment and retention of special education teachers.

General Education Teacher Qualifications and Student Achievement

The association between teacher qualifications and student achievement has been widely studied in the general education context. However, evidence is still mixed with respect to the effects of different types of teacher qualifications on student achievement (Harris & Sass, 2011).

This research generally finds that teacher advanced degree attainment does not lead to improved student performance (Hanushek et al., 2005; Aaronson et al., 2007; Clotfelter et al., 2006; Clotfelter et al., 2007; Buddin & Zamarro, 2009; Ladd & Sorensen, 2015). This could be due to universities not being sufficiently selective in granting graduate degrees to teachers, variations in the quality of institutions granting teaching degrees, and/or graduate degrees no

longer reflecting the level of skills they once used to, given the considerably higher number of teachers with graduate degrees today as compared to several decades ago (Goldhaber, 2016). For administrative decisions, these findings suggest that requiring advanced degrees for teacher hiring or promotion may not be an effective use of resources. However, it is worth noting that while advanced degrees may not generally enhance teaching effectiveness, they could still hold significance for specific groups of teachers, such as those in the early stages of their careers (Ladd & Sorensen, 2017).

Contrary to the effect of advanced degrees, existing research generally shows that teachers become more effective with additional years of experience (Papay & Kraft, 2015; Ladd & Sorensen, 2017; Wiswall, 2013). Although the most significant impact of teacher experience on student achievement is observed in the initial years, the benefits persist beyond the first few years of teaching (Papay & Kraft, 2015; Ladd & Sorensen, 2017; Wiswall, 2013; Harris & Sass; 2011; Kini & Podolsky, 2016; Clotfelter et al., 2007). Understanding how teacher experience relates to student learning is important when considering strategies for hiring, retaining, and compensating teachers (Wiswall, 2013). If teacher effectiveness increases with additional years of experience and the positive effect persists beyond the initial years of teaching, schools should reward experience in promotion and compensation decisions to minimize teacher turnover (Wiswall, 2013). This is especially relevant for special education teachers, who face disproportionally higher turnover rates than general education teachers (Billingsley, 2004).

Evidence from the general education context tends to be mixed when it comes to the role of teachers' regular or subject-specific certification as compared to emergency or no certification. Ample research finds positive associations between regular certification and student achievement (Clotfelter et al., 2007; Darling-Hammond et al., 2005; Easton-Brooks & Davis,

2009; Goldhaber & Brewer, 2000). This positive relationship generally holds when students whose teachers are not certified at all are compared to students of teachers with regular licensure. However, research generally finds no significant differences in learning for students whose teachers have regular certification and those whose teachers have entered the teaching profession through alternative or emergency certification routes (Goldhaber & Brewer, 2000; Constantine et al., 2009). Furthermore, some studies do not find any differences in achievement between students whose teachers are certified and those whose teachers are not certified (e.g., Hanushek et al., 2005). This could be due to state certification requirements not being "strict enough" to ensure that state certification reflects higher teacher effectiveness. Scholars and practitioners have indeed questioned the validity of state certification requirements and procedures when examining teacher certification effectiveness (Hanushek et al., 2005; Wise, 2003). Such findings are especially relevant for determining teacher hiring requirements. If certification does not lead to improved student outcomes, schools should adjust their hiring policies to focus on other more effective skills. This is particularly important for areas with severe teacher shortages, such as special education, where certification requirements might further limit the supply of teachers.

Returns to Teacher Qualifications for Students with Disabilities

Research focusing on the impact of teacher qualifications on the achievement of SWDs is lacking, and the limited evidence available is mixed. For example, one of the most comprehensive studies on the topic to date, by Feng and Sass (2013) using four years of longitudinal student-level data from Florida, finds that SWDs whose teachers are certified in special education perform better in both reading and math than SWDs whose teachers do not have such certification. Conversely, Gilmour (2020), who uses three years of student-level longitudinal data for students with learning disabilities and emotional-behavioral disorders from

North Carolina, finds that special education certification has either a null or negative effect on student achievement in math and reading. The latter findings on teacher special education certification status for students with emotional-behavioral disorders are also supported by Gage et al. (2017), who use data from the Special Education Elementary Longitudinal Study (SEELS). Lastly, Theobald and colleagues (2022), using a combination of survey and administrative data from Washington State, find that students with high incidence disabilities whose teachers had special education endorsement (i.e. graduated from a special education teacher education program) were not significantly different in terms of their reading achievement than students whose teachers did not have such an endorsement. Special education teacher programs are generally expected to increase teacher effectiveness, primarily because of their specialized training tailored to the diverse and unique needs of SWDs. However, the evidence indicating the contrary emphasizes the need for further research focusing on the effects of special education certification and the underlying mechanisms driving these effects.

Evidence is also mixed and limited when it comes to the effect of having teachers with advanced degrees, emergency licensure, and years of experience, on achievement for SWDs. In contrast with the overall findings on the effect of advanced degrees from the general education context, Feng and Sass (2013) find that SWDs gain from having teachers with advanced degrees, an effect which holds for math, but not for reading. This study also finds that teacher experience is positively associated with student achievement, but this effect diminishes later in a teacher's career. Similarly, Theobald et al. (2022) find that students with high-incidence disabilities (i.e., students with emotional/behavioral disorders, specific learning disabilities, or health impairments) experience higher reading gains when taught by more experienced special education teachers. However, the same study found that students with high-incidence disabilities

are no better off when taught by teachers with advanced degrees (Theobald et al., 2022). Gage and colleagues (2017) also found that SWDs do not experience any achievement returns when taught by teachers with advanced degrees; however, unlike other existing research, this study suggests that SWDs do not benefit from more experienced teachers. Lastly, Robinson (2011) concluded that SWDs performed no better in reading under highly qualified teachers (i.e., having a master's degree and subject-specific certification) than they did under teachers not designated as highly-qualified.

The conflicting conclusions emerging from the evidence on returns to qualifications of teachers of SWDs are perhaps a result of inconsistent methodological approaches and diverse types of data used across studies. While three of these studies implement an empirical approach that uses within-student arguably exogenous variation in teacher credentials (Feng & Sass, 2013; Gilmour 2020; Theobald et al., 2022), the others are more exploratory (Gage et al., 2017; Robinson, 2011) or focus on a small sample of participants and self-reported data collected at a given point in time (Robinson, 2011).

At the same time, these studies also differ based on which aspects of teacher preparation they consider, how they measure teacher qualifications, how they operationalize student learning, and what course subjects they include. For example, Gage et al. (2017), Robinson (2011), and Theobald et al., (2022) include ELA teachers only, while Feng and Sass (2013) and Gilmour (2020) consider both math and ELA teachers. Also, Feng and Sass (2013) examine the role of specific certification (i.e., special education) and type of certification (i.e., regular or emergency certification) and Gilmour (2020) examines the role of special education certification and dual certification in general and special education. Conversely, Theobald et al., (2022), focused primarily on early-career special education teachers who were graduates of special education

programs and compared teachers with special education certification with teachers who held dual certification in special education and another subject. Meanwhile, Gage et al. (2017) considered the effect of regular versus no teacher certification. Lastly, while Feng and Sass (2013), Gilmour (2020), and Theobald et al., (2022*)* used standardized math and/or reading test scores as outcome variables, Gage et al. (2017) used six different measures of math and reading skills to create a combined score for both subjects.

Returns to Teacher Qualifications by Classroom Placement and Instructional Approach

In addition to access to effective teachers, the type of classroom environments in which students and teachers interact can shape the learning of SWDs. The Individuals with Disabilities Education Act (IDEA) – the federal law that ensures that all eligible SWDs receive free appropriate public education – requires schools to assign an Individualized Education Program (IEP) for each student who is eligible for special education services (National Center for Learning Disabilities [NCLD], 2021). While the content of IEPs can vary across states, these plans are generally expected to track a student's performance, foresee steps on how to meet achievement goals, and specify the extent to which a student will be included in general education classrooms (NCLD, 2021). As such, schools, in cooperation with parents, determine whether or to what extent SWDs will be educated in less restrictive environments or inclusive classrooms with non-disabled peers, by considering the specific needs of each student (NCLD, 2021). Inclusive classrooms can be co-taught by general and special education teachers, which involves a special education teacher working together with the general education teacher to meet the needs of SWDs (Bowen, 2020). At the same time, inclusive classrooms can be primarily taught by a general education teacher but may have a special education teacher joining the classroom at certain points to support SWDs (Bowen, 2020).

Since SWDs can attend inclusive co-taught, inclusive non-cotaught, and/or self-contained classrooms, assessing teacher effectiveness requires a more comprehensive approach that considers how the effects of teacher qualifications vary by classroom type and instructional approach. It may be that certain aspects of teacher preparation might be strong predictors of student learning in one classroom setting, but not in another. For example, special education licensure might be more important for teachers working with students in self-contained classrooms without co-teachers, since more complex instructional approaches tailored to the specific needs of students may be necessary in such settings. Similarly, students in self-contained classrooms – usually with more intense support needs – might benefit more than their peers in inclusive classrooms by having a teacher who is more experienced, and thus better equipped to respond to their needs. The next two sections present evidence on the broader effects of classroom type and instructional approach on educational outcomes for SWDs, as well as how classroom structures influence the impact of teacher preparation on student outcomes.

Inclusion and Educational Outcomes for Students with Disabilities

The effects of inclusive classroom placement have been widely studied by education policy scholars and practitioners. This research generally reaches consensus that SWDs benefit more from inclusive, as compared to self-contained classroom settings (Hehir et al., 2014; Rojewski et al., 2015; Justice et al., 2014; Theobald et al., 2019; Anderson, 2021). SWDs can benefit from less restrictive classroom environments for multiple reasons, including more opportunities for communication, friendships, and collaboration with other peers in general education classrooms and less disability-based stigma.

The benefits of inclusive education can be reflected in terms of both higher test scores and better post-high-school outcomes, such as postsecondary education enrollment and

participation. For example, Hehir and colleagues (2014) use student-level data from Massachusetts to find that SWDs who are placed in inclusive classrooms outperform those that are placed in more isolated settings in both math and ELA. Another study by Justice et al. (2014) shows that the average language skills of non-disabled peers in inclusive classrooms in pre-school were strong predictors of SWDs' language skills, a finding which establishes the existence of peer effects that promote learning for SWDs placed in inclusive classrooms.

In addition to performance-related benefits, evidence shows that inclusive classroom settings lead to better long-term outcomes. Rojewski, Lee, and Gregg (2015) use data from the second wave of the National Longitudinal Transition Study to find that students with learning and emotional disabilities that spend more time in inclusive classrooms in high school are more likely to enroll and stay in postsecondary education than students that spend less time in inclusive classrooms. Similarly, Flexer et al. (2011) collected longitudinal data on SWDs within a large Great Lakes state and found that inclusion in general education was linked to a higher likelihood of full-time college enrollment, but this effect varied based on disability type. The latter finding highlights the importance of considering disability type when studying the effects of various classroom settings, and the role of teacher preparation, on student learning.

Despite the copious evidence on the positive effects of inclusive education, a few studies instead find positive learning gains for students placed in separate self-contained classrooms. For example, a study by Hanushek, Kain, and Rivkin (2002), using data from Texas, finds that SWDs face significant achievement gains in mathematics from being placed in self-contained classrooms. And Fuchs et al. (2015) note that even when students with learning disabilities technically have access to general education classroom settings, they may require intensive supplemental supports to truly benefit from the general education curriculum. These findings

highlight the need for further investigation on both the overall effect of classroom placement and the role of teachers as key determinants of students' classroom experience.

While extensive research points to the general advantages of inclusive classroom placement for SWDs, there remains a substantial knowledge gap regarding the impact of classroom placement on the outcomes associated with teacher preparation. The study by Feng and Sass (2013) is the only study to my knowledge that examines student gains from teacher qualifications in different types of classrooms. This study found that the effects of advanced degrees and special education certification do not differ based on whether SWDs attend special education or inclusive general education classrooms. Feng and Sass did, however, find that experience has a larger impact on student achievement for students in general, as opposed to self-contained classrooms. This different effect was only found for math, but not for reading.

Co-teaching and Educational Outcomes for Students with Disabilities

While the advantages of placing students in inclusive classrooms have been extensively documented in education research, very limited research attention has been given to co-teaching, an instructional approach commonly used in inclusive classrooms (Jones & Winters, 2022; Murawski & Swanson, 2001). Co-teaching is a promising collaborative educational approach where usually two qualified teachers, typically a general educator and a special educator, work together in the same classroom to provide instruction to all students, including those with disabilities (Friend et al., 2015). In this way, co-teaching is expected to enhance learning and improve SWDs' educational experiences through a more inclusive learning environment where SWDs can access the general education curriculum and receive support tailored to their individual needs.

The most comprehensive study on co-teaching effectiveness to date, by Jones and Winters (2022) using longitudinal data from Massachusetts, reveals that co-teaching results in modest positive gains for SWDs' skills in ELA in elementary grades, but this effect is negative for SWDs in secondary grades. Jones and Winters (2022) also found positive, but small, effects of co-teaching on students' math test scores, and these results were mainly driven by SWDs in elementary grades. Furthermore, in a meta-analysis of research on co-teaching, Murawski and Swanson (2001) found moderate positive effects of co-teaching (i.e. student placement in inclusive co-taught versus non-co-taught classroom) on student outcomes. This meta-analysis included only six existing quantitative cross-sectional studies on co-teaching, which focused on a wide range of outcomes including attitudes, referrals, absences, social skills and friendships, and achievement. Lastly, another recent meta-analysis by King-Sears and colleagues (2021) found that SWDs perform better when placed in co-taught classrooms, but they compared students in co-taught classrooms with students in self-contained settings. Much of the other existing research on co-teaching involves descriptions of programs and effective practices, as well as discussions about co-teaching logistics, the professional relationship between co-teachers, and implementation challenges (Friend et al., 2015).

Overall, the small and marginally significant findings in the limited existing research and the general lack of causal research on co-teaching call for further research focusing on co-teaching effectiveness alone and the interaction between co-teaching and overall teacher effectiveness. No study has so far investigated how the effects of the main classroom teachers' preparation on outcomes for SWDs differ based on the presence of co-teachers in the classroom.

Current Study

This study is an attempt to address the evident gap and lack of consensus in the literature on the impact of teacher preparation on learning for SWDs. The study contributes to existing literature on teacher effectiveness for SWDs in two main ways. First, this study offers new insights on teacher effectiveness for SWDs through an examination of more modern and comprehensive data covering a longer period than previous studies. The study by Feng and Sass, for instance, used data from the 2000-01 to 2004-05 school years, which is also the period during which the No Child Left Behind Act (NCLB) was introduced. However, NCLB's effects on the operation of schools could perhaps not be felt in the early years of its implementation, which is why by using more recent data, this study will speak to questions of teacher effectiveness for SWDs in a more current context. The study by Gilmour (2020) used the same data from North Carolina that I use in this study, but it only covered three years of data from 2010-11 to 2012-13 and focused only on the population of students with learning disabilities or emotional-behavior disorders. She also focused on teacher certification, whereas I also consider other teacher qualifications such as years of experience and degree attainment. As such, by covering more years of data, focusing on the whole population of SWDs and expanding the types of teacher qualifications assessed, I can offer new insights to extend the existing evidence on teacher effectiveness for SWDs.

Second, this study focuses on effects of teacher preparation across cotaught general education, non-cotaught general education, and self-contained classrooms. This approach differs from the Feng and Sass (2013) study that only compared the relationship between teacher qualifications and student achievement between general and self-contained classrooms. The current study is the first to examine how the effects of the main teacher qualifications are influenced by the presence of a co-teacher in the classroom.

Methods

Data

This study uses seven years of linked student, classroom, and teacher data from the North Carolina Education Research Data Center, spanning the 2006-07 to 2013-14 school years. I restrict the sample to students identified as "exceptional children," which is the term used by the North Carolina Department of Public Instruction to designate any student with an individualized education program (IEP). Within this broader classification, the sample includes the following categories of student disabilities: autistic, deaf-blind, developmentally delayed, behaviorally/emotionally disabled, educable mentally disabled, hearing impaired, intellectually disabled, specific learning disabled, multi-handicapped, other health impaired, orthopedically impaired, speech-language impaired, severely/profoundly mentally disabled, traumatic brain injured, trainable mentally disabled, and visually impaired. The most common disability category is specific learning disabled, representing approximately half of the student sample (Table 3). Due to very small sample sizes for certain disability classifications[1], in this analysis, I combine this set of disabilities into a single category of low-incidence disabilities.

To assess effects of teachers and classroom structures on student learning, I use as primary outcomes student end-of-grade reading and math test scores, standardized by grade and year within this sample to have a mean of zero and standard deviation of one. I focus only on SWDs who took the regular or modified assessment and exclude students who took alternate assessments given that their test scores are not comparable with other students.

To facilitate matching of students to teachers, I identify for each student with an IEP their primary math classroom and primary ELA classroom in each grade level between the third and eighth grades.[2] For some students, these math and/or ELA classrooms may be inclusive

classrooms. For other students, these math and/or ELA classrooms may be designated instead as self-contained classrooms. The identification of classroom type (inclusive vs. self-contained) is based on unique course codes in the North Carolina data. General education classrooms would contain both SWDs and students without disabilities, but the analytical sample only includes the SWDs attending those general education classrooms. SWDs more frequently attend inclusive general education classes than self-contained classrooms, which only represent about nine percent of students in the sample. This representation of separate special education classrooms is similar to the Feng and Sass (2013) sample in Florida, in which about 11 percent of students in their analytical sample were placed in self-contained classrooms.

Further, in inclusive classrooms, students may have a co-teacher, which is the case for about 7 percent of SWDs in this study's sample. I define co-taught classrooms based on whether, within an inclusive classroom, there are two teachers and at least one is classified as co-teacher.[3] Jones and Winters (2022) found that about 11.5 percent of classrooms had one teacher and one co-teacher, which is slightly higher than my estimate. This can be because their study focuses on both SWDs and their non-disabled peers, while I restrict my analysis to SWDs only.

Finally, in some cases, particularly in elementary school grades, students may have the same teacher for both math and ELA subjects ("multi-subject"). In this case, I match the same teacher to the student twice, once for math, and once for ELA, and the same teacher therefore appears in both the math score and reading score regressions. My final analytical sample includes 145,017 student-year observations in ELA or multi-subject classrooms and 157,537 student-year observations in math or multi-subject classrooms.

For the primary teacher in each classroom, I link to data on the teacher's qualifications and characteristics. First, I capture whether the teacher has licensure only in special education,

only general education licensure (i.e., content area or general elementary level license), and/or dual licensure in special education and general education. The special education licensure includes the following categories: special education general curriculum, special education adapted curriculum, and other K-12 exceptionality areas specific to SWDs. The latter include certification in the following disability areas: cross categorical (mildly/moderately disabled), severely/profoundly disabled, mentally disabled, visually impaired, physically/orthopedically disabled, behaviorally/emotionally disabled, learning disabled, and hearing impaired.

Second, I capture whether the teacher has only a lateral entry or provisional license, which represents an alternative pathway into teaching in which the individual can begin a teaching position with the agreement to pursue training towards full educator licensure. Third, I capture teacher years of experience from state payroll codes. In this analysis, I divide the experience variable into seven bins (no experience, 1 to 3 years, 4 to 6 years, 7 to 11 years, 12 to 16 years, 17 to 25 years, and over 25 years) to explore nonlinearities in the relationship between teacher experience and student achievement, as suggested by previous literatures (e.g., Feng & Sass, 2013; Ladd & Sorensen, 2017). Lastly, I capture whether each teacher has an advanced degree such as a master's degree or doctoral degree. Although there are many potentially relevant teacher credentials, these licensure, experience, and education variables reflect important potential predictors of student learning (Clotfelter et al., 2007; Harris & Sass, 2011)

Empirical Model

The central purpose of this study is to examine the effect of teacher qualifications on the learning of SWDs, and to determine whether these effects differ by classroom setting. To estimate these effects, I specify a student fixed effect model with student test scores as the outcome variable. I repeat this regression for three types of classrooms: general education co-

taught, general education non-co-taught and self-contained classrooms. I also repeat each regression for both math test scores, in which the student is matched to their primary math classroom, and for reading test scores, in which the student is matched to their primary ELA classroom:

$$A_{ijgst} = \beta_0 + \beta_1 cotaught_{it} + \beta_2 speced_{it} + \beta_3 TP_{jt} + X_{ijt}\beta_4 + \omega_i + \gamma_s + \theta_g + \delta_t + \varepsilon_{ijgst}$$

In this equation, achievement in math or reading of student *i* with teacher *j* in grade *g* in school *s* and year *t* (A_{ijgst}) is a function of an indicator of a self-contained special education classroom ($speced_{it}$) and co-taught ($cotaught_{it}$) classroom type for the given student and subject, and a vector of the credentials of the primary teacher in this classroom (TP_{jt}). The excluded classroom categories are inclusive classrooms without co-teachers. In the disaggregated regressions by classroom type, I exclude $speced_{it}$ and $cotaught_{it}$. I cluster standard errors by teacher, which represent the treatment assignment level for the treatments of interest (teacher credentials).

The model also controls for a vector of student, teacher, and classroom controls (X_{ijt}). Student characteristics include time varying factors which are not captured by student fixed effects, such as testing accommodations and whether they have the same race and sex as their teacher. Teacher controls include teacher race and sex and classroom controls including classroom type (single- or multi-subject), classroom size, lagged classroom achievement in math or reading, and share of SWDs in the classroom. Finally, the model controls for student (ω_i), school (γ_s), grade (θ_g), and year (δ_t) fixed effects. Because of the high-dimensional and multi-level nature of this data, I use the reghdfe command in Stata to perform fixed effects estimation (Correia, 2019).

Student fixed effects models are an appropriate choice for this analysis because they enable the control of all time-invariant characteristics of students. This is particularly crucial

when studying SWDs, as they exhibit varying ability levels and are exposed to both general and special education teachers in a wide range of classroom settings. First, SWDs are themselves a very diverse group of students with varying ability levels. This requires a careful treatment of student heterogeneity when estimating returns to teacher preparation for SWDs (Feng & Sass, 2013). By employing a student fixed effects approach, I can effectively assess the impact of teacher preparation on SWDs' achievement while accounting for the inherent differences among students, including disability type. Second, the use of student fixed effects helps control for biases stemming from the non-random assignment of students into classrooms. This is especially relevant when studying the impact of teacher preparation, as SWDs might be differentially placed in classrooms with varying levels of instructional quality.

One main alternative to the student fixed effects approach is a lagged test score approach. In this approach, lagged test scores serve as a proxy for all prior inputs that influenced student achievement prior to year *t*. Chetty, Friedman, and Rockoff (2014) show that controlling for lagged student test scores in value added models of teacher effectiveness helps account for biases resulting from the non-random student sorting into classrooms. However, value-added models that control for observable student characteristics may still be limited due to biases resulting from unobservable student characteristics, such as inherent ability. As such, a student fixed effects approach that controls for unobservable time-invariant student characteristics is the preferred approach for this study.

Patterns of Teacher Sorting

The assignment of students to schools, classrooms, and teachers does not occur at random. This systematic sorting, which often links more disadvantaged students to less qualified teachers, happens both across schools (Betts et al., 2000; Lankford et al., 2002) and within

schools (Kalogrides & Loeb, 2013; Kalogrides et al., 2013). For SWDs, the assignment to supportive classroom environments, and access to highly qualified teachers, may be particularly important (Gilmour & Henry, 2018; Lai et al. 2020). And prior research suggests that access to highly qualified special education teachers varies significantly across school settings (Mason-Williams et al., 2017).

<<<Table 1>>>

I examine first the qualifications and characteristics of teachers working in inclusive and self-contained classrooms. I classify classrooms both by their subject type – math, ELA, or multi-subject – and by their inclusive or self-contained status (Table 1). Within math subjects, teachers in inclusive classrooms are less likely to only have a special education license (4.03 percent compared to 49.41 percent), dual licensure in special and general education (2.92 percent compared to 34.44 percent), or a lateral or provisional entry license (5.03 percent compared to 14.01 percent), than teachers in self-contained special education classrooms. Inclusive classroom math teachers also have slightly less teaching experience than their counterpart special education math teachers (11.84 years compared to 13.01 years) and are less likely to hold advanced degrees (29.97 percent compared to 38.49 percent). Finally, demographic characteristics differ somewhat between these groups, with inclusive math classroom teachers being more likely to be White and self-contained math classroom teachers more likely to be Black.

The patterns of teacher sorting across ELA classroom types are quite similar to those across math classroom types (see Table 1, columns 3 and 4). Self-contained classroom ELA teachers are more likely to only hold special education licensure (48.71 percent compared to 5.38 percent) or dual licensure in special and general education (37.09 percent compared to 3.59 percent). Once again, more teachers in self-contained special education classrooms are working

under lateral or provisional licenses than are their general education peers (11.91 percent compared to 5.19 percent); however, they also have more years of teaching experience on average (13.72 years compared to 12 years) and higher prevalence of advanced degree attainment (39.48 percent compared to 33.02 percent). Finally, as with the math sample, more special education teachers are Black than general education teachers (21.53 percent compared to 13.23 percent). These same general patterns of teacher sorting across inclusive and self-contained math and ELA classrooms hold for multi-subject classrooms, but the sample size is smaller for this third group.

The implications of these teacher sorting patterns for the distribution of instructional quality are ambiguous. A significant number of special education teachers (i.e., teachers in self-contained classrooms) hold only provisional or lateral teaching licenses, which may indicate desperation on the part of schools and districts aiming to fill their numerous special education teaching vacancies with even uncertified candidates (USDOE, 2017). On the other hand, special education teachers appear to have higher qualifications in other dimensions, on average, such as experience levels and advanced degree attainment. Assessments of the value of these different teacher qualifications for learning of SWDs, by classroom type, is needed to better understand such tradeoffs in teacher recruitment and effectiveness.

<<<Table 2 >>>

I then examine the qualifications and characteristics of main teachers working in inclusive co-taught and non-co-taught classrooms. I classify classrooms both by their subject type – math, ELA, or multi-subject – and by their co-taught or non-co-taught status (Table 2). Math teachers in classrooms without co-teachers are more likely to have a special education license than teachers in classrooms with co-teachers (6.51 percent compared to 2.89 percent).

Main teachers in classrooms without co-teachers are also more likely to have dual licensure in special and general education (4.77 percent compared to 0.57 percent) and have an advanced degree (30.65 compared to 26.96 percent) but are slightly less experienced than teachers in co-taught classrooms (11.87 percent compared to 12.31 percent). Also, main teachers in classrooms without co-teachers are somewhat less likely to be laterally or provisionally certified than teachers in classrooms with co-teachers (5.37 percent compared to 6.73 percent). Lastly, main teachers in co-taught classrooms are more likely to be White and teachers in non-co-taught classrooms are more likely to be Black.

The patterns of teacher sorting across ELA co-taught and non-co-taught classrooms are similar to those across math classrooms (see Table 2, columns 3 and 4). ELA teachers in classrooms without co-teachers are more likely to only have a special education license than teachers in classrooms with co-teachers (8.75 percent compared to 3.95 percent). Main teachers in classrooms without co-teachers are also more likely to have dual licensure in special and general education (6.34 percent compared to 0.89 percent) and have an advanced degree (33.66 compared to 31.25 percent). However, they are slightly less experienced (12.10 percent compared to 12.33 percent) and are less likely to be laterally or provisionally certified than teachers in classrooms with co-teachers (5.51 percent compared to 7.25 percent). Lastly, the demographic characteristics of main teachers in co-taught and non-co-taught classrooms differ slightly, with teachers who have co-teachers being more likely to be White. These same general patterns of teacher sorting across co-taught and non-co-taught math and ELA classrooms hold for multi-subject classrooms, but the sample size is smaller for this third group.

Overall, inclusive classroom teachers whose instructional approach involves collaboration with co-teachers, are less likely to hold special education credentials, than teachers

in classrooms without co-teachers. This could potentially impact the instructional quality for SWDs, as there might be less targeted support available if the assigned co-teacher would also lack such certification. Moreover, the prevalence of dual licensure among main teachers in classrooms without co-teachers could indicate that these teachers are expected to manage both types of students, potentially stretching their abilities to provide specialized support to SWDs while also attending to the needs of students without disabilities. Lastly, the slightly higher experience level of teachers in co-taught classrooms, might contribute to better instructional quality due to the accumulated expertise and familiarity with teaching strategies. These implications present a challenge in the study of co-teaching as an instructional approach, as it becomes complex to distinguish the effects of co-teaching from the variations in instructional quality among teachers assigned to either co-taught or non-co-taught classrooms.

Patterns of Student Sorting

<<<Table 3 >>>

Table 3 presents information on the average characteristics of students across math, ELA, and multi-subject inclusive and self-contained classrooms. Across all subjects, it is immediately apparent that SWDs in inclusive classrooms tend to be higher performing on end-of-grade test scores than SWDs in self-contained classrooms. The average difference in test scores between inclusive and self-contained settings ranged from 0.51 standard deviations in reading scores in ELA classrooms to 0.62 standard deviations in math scores in math classrooms. This likely reflects in large part that schools may place students with more severe disabilities in self-contained classrooms and may place students with more mild disabilities in inclusive classrooms. For instance, behaviorally/emotionally disabled students are disproportionately represented in self-contained classrooms across all subjects. Students on the autism spectrum are also

overrepresented in math and multi-subject self-contained classrooms. However, students with specific learning disabilities and speech-language impairments have more representation within inclusive classrooms. Finally, from a demographic perspective, female, White, and Hispanic students are more commonly found in inclusive classrooms, whereas male and Black students are more commonly found in self-contained classrooms. To the extent that classroom type matters for student achievement and growth, these disproportionalities in classroom assignment could influence larger patterns of educational inequality.

<<<Table 4>>>

Table 4 presents information on the average characteristics of students across math, ELA, and multi-subject classrooms with and without co-teachers. SWDs in classrooms with co-teachers have slightly lower test scores than students in non-co-taught classrooms. The average difference ranges from 0.03 standard deviations in reading test scores in ELA classrooms to 0.11 standard deviations in math test scores in math classrooms. This is perhaps a reflection of the higher instructional support needs in classrooms that get co-teachers. However, these differences do not seem, at least descriptively, to be related to the placement of students with relatively more severe disabilities in inclusive co-taught as compared to non-co-taught classrooms. Co-taught classrooms have a higher prevalence of students with learning disabilities and a lower representation of behaviorally/emotionally students. However, classrooms without co-teachers have a disproportionally higher share of speech-language impaired students than non-co-taught classrooms. Thus, the implications for disability severity on differences in achievement levels between students in classrooms with and without co-teachers are ambiguous. Lastly, SWDs in classrooms with co-teachers are more likely to be female and White. Overall, the diverse range of student characteristics, instructional support needs, and disability types in co-taught and non-

co-taught classrooms paints a complex picture, and further analysis is needed to better understand the implications of these descriptive findings.

Effects on Student Achievement

Tables 5 and 6 present the estimated effects of teacher qualifications and classroom environments on the achievement of SWDs. Model 1 includes only the classroom type variables and Model 2 includes classroom type and teacher qualification variables. In the three next models, I repeat the model with all teacher qualifications across the three classroom types. Model 3 includes teacher qualification variables in inclusive co-taught classrooms, Model 4 includes teacher qualification variables in inclusive non-co-taught classrooms, and Model 5 includes teacher qualification variables in self-contained classrooms. All models include controls for classroom peer characteristics, time-varying student and teacher characteristics, and student, school, grade, and year fixed effects.

<<<Table 5>>>

The first finding of note, in column one of Table 4, is that students placed in co-taught classrooms perform better in math than students placed in classrooms without co-teachers, to the magnitude of 0.017 standard deviations ($p<0.05$). This effect remains relatively constant at 0.016 standard deviations but becomes marginally significant ($p<0.1$) when I add controls for teacher qualifications. The modest positive effects of co-teaching on SWDs' math test scores I find in this study are in line with previous findings from Jones and Winters (2022). Following the work of Jones and Winters (2022), I examine how the impact of co-teaching differs by grade level, and similarly find that the positive effects of co-teaching are mostly driven by students in elementary grades (see Appendix, Figure 1A).

The other finding of note in column one is that the effect of being placed in a self-contained classroom on SWDs math achievement is negative, but marginally significant ($p<0.1$). This effect loses significance once I consider the effects of teacher qualifications, although the magnitude does not change. To explore this result further, I assess how the effect of placement in self-contained classrooms differs by grade level and find that the negative effects of self-contained settings on math test scores are being primarily driven by students in secondary grades (see Appendix, Figure 2A). The larger negative effects for SWDs in secondary grades can be due to the increased demand for a broader spectrum of subject-specific knowledge and expertise in secondary grades compared to the foundational curriculum typically encountered in elementary education.

In column two of Table 5, I estimate the average returns to teacher qualifications for SWDs across all classrooms. There are several important findings here. First, teachers with special education licensure or dual licensure in special and general education are no different than teachers with only general education licensure in improving math test scores for SWDs. These findings on the insignificant effects of special education certification mirror closely those found by Gilmour (2020).

Further, teacher experience is positively associated with student math scores at all levels of teacher experience ($p<0.01$ for all experience bins), but this effect is nonlinear as it varies by level of experience. Students whose teachers have one to three years of experience perform, on average, 0.052 standard deviations higher than students whose teachers have less than one year of experience. These returns to teacher experience for SWDs peak at 17 to 25 years of experience, which is associated with 0.072 standard deviations growth in student math

achievement. None of the other teacher credentials had significant association with student learning.

To dig further into these findings, I estimate the effects of teacher qualifications by classroom type in column three to five. It could be the case, for instance, that certifications in special education are less valuable in inclusive classrooms than in self-contained special education classrooms. Special education licensure could also be more beneficial in inclusive classrooms without co-teachers than in inclusive classrooms with co-teachers who may bring in the special education expertise. However, the results suggest that SWDs face gains in math achievement from having special education certified teachers only when placed in inclusive co-taught classrooms. Main teachers with special education certification in co-taught classrooms, have a large and positive effect on student learning in math by 0.178 standard deviations ($p<0.01$). This effect remains insignificant but is positive for students in self-contained classrooms and negative for students in inclusive, non-co-taught classrooms. This surprising pattern necessitates a closer examination of co-teachers' characteristics in future research, to identify the underlying mechanisms driving these results.

Another surprising finding is the positive and large significant effect for provisionally or laterally licensed teachers in inclusive co-taught classrooms. This positive and significantly large effect for provisionally or laterally licensed teachers in inclusive co-taught classrooms might be because these teachers, being newer to the profession, could be more open to collaboration and innovative teaching methods, which can synergize effectively with the co-teaching model to benefit SWDs.

The same general findings of effects of all other teacher credentials from Model 2 remain in models three to five. However, the effect of teacher experience becomes insignificant in

inclusive co-taught and self-contained classrooms, potentially due to low statistical power associated with the relatively lower sample sizes for these classrooms. These results also suggest that the effects of teacher experience are primarily being driven by teachers in inclusive non-co-taught classrooms.

<<<Table 6>>>

In Table 6, I repeat the same exercise by linking student growth in ELA achievement to teacher and classroom characteristics. As seen in column one, students in co-taught classrooms outperform students in classrooms without co-teachers by 0.013 standard deviations ($p<0.01$). This effect loses some significance and shrinks slightly when adding teacher qualifications but remains positive. Similar to math regressions, I also examine how the effect of co-teaching on reading test scores differs by grade level and find that, although there are positive gains from co-teaching for both SWDs in elementary and secondary grades, these gains are higher for students in elementary grades (see Appendix, Figure 1A). These findings are somewhat inconsistent with previous evidence from Jones and Winters (2022) who finds positive effects for ELA in elementary grades, but negative effects in secondary grades.

Furthermore, SWDs fare significantly worse in reading in self-contained classrooms than they do in inclusive general education classrooms. The effect of placement in a self-contained classroom is -0.03 standard deviations ($p<0.01$). This difference between special education and general education environments remains when I add teacher covariates but loses some statistical significance and shrinks slightly to -0.026 standard deviations ($p<0.05$), implying that teacher preparation differences may explain a small portion of the adverse effects of self-contained classroom placement.

In the regression with teacher qualification measures added (column 2), I observe that most of the teacher credentials do not have significant effect on students reading test scores. Having teachers with special education certification does not make students better off than having teachers with only general education certification. This is again consistent with the overall findings of Gilmour (2020), although unlike her, I find that dual licensure in special and general education also has no relative effect on reading achievement.

As with the math regressions, teacher experience significantly improves student achievement. SWDs whose teachers have one to three years of experience perform, on average, 0.022 standard deviations ($p<0.05$) higher on reading tests than students whose teachers have no experience. Similarly, students with teachers who have four to six years of experience outperform students whose teachers have less than a year of experience by 0.028 standard deviations ($p<0.01$). Different from math regressions, the effect of teacher experience on reading achievement does not appear start decreasing at a later point in teachers' career. As seen in column two, the highest coefficient estimate is at more than 25 years of teacher experience (0.044 standard deviations, $p<0.01$).

The models in columns three to five include estimated effects of teacher qualifications by classroom type. Similar to the main results, the results by classroom type suggest that most teacher credentials are unrelated to students' achievement in reading. I do uncover one interesting finding here, though. Teachers with special education licensure teaching in self-contained classrooms are significantly more effective at improving reading scores than teachers with general education licensure, with an effect size of 0.192 standard deviations ($p<0.05$). This is likely due to the heightened requirements and demands associated with special education instruction in self-contained settings. There is also a large, but marginally significant effect for

dual licensure in self-contained classrooms, which should primarily be driven by the large effect of special education licensure.

Lastly, similar to the findings from math regressions, the effects of teacher experience remain positive in inclusive non-co-taught classrooms but are not significant in self-contained or inclusive co-taught classrooms. This again may be due to low power issues stemming from relatively lower sample sizes in these classrooms, suggesting that the effects in the main models are primarily driven by students and teachers in inclusive classrooms without co-teachers.

Sub-Analyses by Disability Category

Although all SWDs face unique challenges and educational experiences which determine their achievement levels, students with specific types of disabilities may face relatively more challenges than others and/or have differing instructional needs. Previous research indicates that there is significant variation in overall achievement levels across different disability types (Gilmour et al., 2019), as well as in the effects of teacher preparation on achievement (Gilmour, 2020; Feng & Sass, 2013). As such, in addition to the main analyses which assess returns to teacher qualifications for all SWDs, I run separate regression models for students in each disability category.

The results of sub-analyses by disability category suggest that the same general findings hold across most disability categories. Most teacher credentials, including special education certification, dual licensure, alternative licensure, and advanced degrees, seem to be unrelated with student achievement in math and reading (please see Table 1 and 2 in the Appendix). Teacher experience remains positively associated with student achievement in math and reading for most disability types, but loses significance for some categories, potentially due to the decreased statistical power associated with lower sample sizes for some of the categories. Figure

1 presents returns to teacher experience by disability category in terms of SWDs' achievement in math and Figure 2 presents returns to teacher experience by disability category in terms of SWDs' reading achievement.

The effect of teacher experience is positive and significant for students with learning disabilities (LD) and students with speech impairments (SI) in both math and reading. Once again, in math regressions, there is a non-linear effect, whereby the highest returns to teacher experience occur at 17 to 25 years of experience. However, for reading achievement, teacher experience significantly affects test scores only after eleven years of teaching experience. Contrary to the results from the main ELA models, the effect of experience peaks at 17 to 25 years of experience and starts to slightly decrease after 25 years of experience.

Furthermore, for students on the Autism spectrum (AU), there is a difference in the direction of the effects of teacher experience between math and ELA. Teacher experience has statistically significant and high returns to SWDs' reading achievement – especially at higher levels of experience – but insignificant and negative effects on student achievement in math. This could be due to more experienced ELA teachers perhaps being better equipped to adapt instruction to the unique needs of each student. On the contrary, math instruction might rely more on standardized methods and curricula, where experience could potentially lead to the unintentional exclusion of innovative, tailored strategies.

The effect of teacher experience remains positive but insignificant at most levels of experience for emotionally/behaviorally disabled students. This could be attributed to low statistical power due to only about four percent of the total sample of SWDs having such a disability. However, the insignificant effect could also be related to the fact that emotional-behavioral disabilities are relatively more severe compared to most disability categories, which

may necessitate a more specialized approach to instruction and support, making it less responsive to variations in teacher experience levels when compared to less severe disabilities.

Lastly, for students with other health impairments (OH), which generally include chronic health conditions that may affect students' educational performance, teacher experience leads to positive and statistically significant gains in math, but not in reading.

Overall, these results suggest that teacher experience plays a more significant role in determining student achievement in math for students with relatively milder disabilities, such as learning disabilities, speech impairments, and other health impairments. Conversely, teacher experience positively influences student achievement in reading for students with relatively more severe disabilities, such as Autism. This nuanced pattern underscores the importance of tailoring teacher training and support to meet the diverse needs of students across the spectrum of disabilities.

Discussion and Conclusion

Special education instruction and student outcomes receive relatively little research and policy attention despite the unique educational needs of SWDs and the growing share of public school students with IEPs (De Brey et al., 2021). In a vacuum of information about what works in special education and why, school administrators have adapted a variety of staffing and tracking approaches for educating SWDs, from "pull-in" approaches that include SWDs in inclusive classrooms, to "pull-out" approaches that separate SWDs, to approaches that require particular certification credentials for special education instructors. Notably, these approaches carry different implications for the teacher labor market. "Pull-out" approaches for teaching self-contained special education classrooms create a substantial need for special education specialized teachers in the midst of a broader special education teacher shortage. Similarly,

special education certification requirements might constrain the supply of special education teachers further. Meanwhile, "pull-in" strategies often necessitate additional support from co-teachers with special education expertise to adequately meet the diverse needs of SWDs in inclusive classrooms.

I aim to sort out the extent to which the potential costs of these approaches yield returns in student learning to better inform special education policy. The following themes emerge from this analysis. First, SWDs with special education certified teachers do not experience significantly different learning outcomes compared to students whose teachers have general education certification. This is consistent with previous work from Gilmour (2020) and Theobald et al. (2022). There are a few potential explanations for these findings. First, this type of certification might not help teachers meaningfully improve learning for SWDs. This could be due to special education certification requirements and curricula not being tailored to specific student needs or just due to certification programs being poorly aligned to student learning generally. Another plausible explanation is that there is a weaker pipeline of teachers entering special education certification and specialization programs. This could be related to special education being a more challenging, but not relatively more rewarding teaching area. Finally, these results might be due to special education teachers not receiving age-specific pedagogical training. In North Carolina, special education certification is a K-12 certification, but math and ELA certifications are grade-level-specific (e.g., K-6, middle school, secondary school). This might lead to mismatches at the school-level or a steeper learning curve for special education teachers in adjusting to the age ranges of students at the school in which they are ultimately hired.

Second, the findings of this study suggest that schools may benefit from shifting away from separate tracks for SWDs to the extent possible. Overall, I observe larger growth in achievement among SWDs in inclusive classrooms relative to self-contained special education classrooms. These findings are consistent with the extant evidence on the benefits of including SWDs in mainstream education (Hehir et al., 2014; Rojewski et al., 2015; Justice et al., 2014; Flexer et al., 2011). Given that each additional exclusive classroom must be staffed by an additional teacher, minimizing the use of exclusive special education classes might ease the extant pressures on the special education teacher labor market.

Third, SWDs face modest improvements in learning outcomes when placed in inclusive classrooms with co-teachers as compared to inclusive classrooms without co-teachers. This is in line with previous evidence from Jones and Winters (2022). The positive yet relatively small effect sizes highlight the need for further research to identify the specific elements of co-teaching that can enhance SWDs' outcomes. Prior evidence from a nationally representative survey of K-12 general and special education educators highlights the challenges they encounter, particularly related to insufficient administrative support and planning time with teaching partners (Sparks, 2022). To maximize the benefits of co-teaching, it is crucial that administrators provide enhanced support to address these barriers and enable successful implementation of collaborative teaching.

Finally, SWDs perform better in math and reading tests when taught by more experienced teachers as compared to teachers with less than one year of experience, aligning with previous evidence from Feng and Sass (2013). The consistent positive returns to teacher experience emphasize the need for strategies to attract and retain experienced educators who can make a meaningful impact on the academic growth of SWDs. This is particularly relevant in special

education as one of the teaching areas most significantly affected by high teacher turnover rates (Diliberti & Schwartz, 2023).

Despite providing novel insights on the impact of teacher qualifications and classroom settings on learning SWDs, this study has a few limitations that can motivate further research. First, in my analysis I link each student to their primary math and ELA teacher, but this approach does not allow me to link the same student to more than one teacher within the same subject and grade. Given that students sometimes have more than one teacher (and/or co-teacher) within the same subject and grade, by linking each student to their primary teacher I am not considering the full effect on learning that might be due to other teachers' instruction. I partly address this limitation by considering the effect of one co-teacher, but further research should explore the specific aspects of co-teacher preparation that matter for SWDs, and the role of other teachers are assigned to the classroom on a non-regular basis. Another related limitation is the identification of co-taught classrooms as those that include one main teacher and one co-teacher, which involves excluding any classroom that may involve more than one co-teacher from the analysis. Finally, this study is limited to test scores as a measure of student learning, which could arguably also be measured through other non-test-based measures. Future research should look to collect data from SWDs on other important outcomes, such as parents' views of their child's development and services, longitudinal outcomes on socio-emotional skills and other non-cognitive skills, and perhaps college and labor market outcomes.

To conclude, this study's results suggest that administrators could adjust to the current shortage of special education teachers by including as many SWDs as possible in general education classrooms, perhaps complemented with additional co-teachers or teacher aides (Clotfelter et al., 2016; Hemelt et al., 2021; Jones & Winters, 2022). Such strategies could help

better target resources to minimize the use of teachers with special education certification in special education classrooms. The results also suggest that schools can effectively respond to the shortage of special education teachers by relaxing their requirements for special education certification. Given the questionable learning benefits from special education certified instructors, credential requirements for special education may inhibit schools from recruiting otherwise effective teachers who can improve the learning of SWDs. Moreover, these results raise concerns about the benefits of special education certification more broadly. Policymakers, schools, and education training programs should consider ensuring special education teachers receive sufficient training to be effective instructors or increasing pay for special education instructors to account for the higher difficulty of the area and attract more candidates.

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Tables and Figures

Table 1. Main Teacher Qualifications and Characteristics by Classroom Type (Inclusive vs Self-Contained)

	Classroom Type					
	Single Subject: Math		**Single Subject: ELA**		**Multi-subject**	
	Inclusive	Self-contained	Inclusive	Self-contained	Inclusive	Self-contained
Advanced degree	29.97	38.49***	33.02	39.48***	27.95	40.55***
Special education license	4.03	49.41***	5.38	48.71***	6.99	34.81***
General education license	90.94	36.58***	89.43	39.39***	89.31	49.38***
Dual licensure	2.92	34.44***	3.59	37.09***	5.71	48.15***
Lateral/Provisional license	5.03	14.01***	5.19	11.91***	3.70	15.81***
Experience	11.84	13.01***	12.00	13.72***	10.82	12.77***
Female	86.09	86.53	91.75	88.20***	91.47	91.76
White	83.51	71.66***	83.16	71.96***	84.81	77.03***
Asian	0.62	0.39***	0.36	0.19***	0.41	0.51
Black	12.29	23.18***	13.23	21.53***	12.06	19.98***
Hispanic	0.62	0.64	0.62	0.40***	0.86	0.15***
American Indian	1.05	2.59***	0.78	3.97***	0.24	1.49***
Observations	*241,292*	*12,470*	*235,875*	*17,476*	*33,148*	*1,942*

***p < 0.01, **p < 0.05, and *p < 0.1 refer to mean-difference t-tests between self-contained and inclusive classrooms for each subject. The values in the table represent percentages, except for teacher experience, which is an average. Observations are at the student-year level.

Table 2. Main Teacher Qualifications and Characteristics by Classroom Type (Co-taught vs Not Co-taught)

	Classroom Type					
	Single Subject: Math		**Single Subject: ELA**		**Multi-subject**	
	Co-taught	Not Co-taught	Co-taught	Not Co-taught	Co-taught	Not Co-taught
Advanced Degree	26.96	30.65***	31.25	33.66***	23.33	28.88***
Special education license	2.99	6.51***	3.95	8.75***	2.19	8.82***
General education License	90.28	88.12***	88.80	85.73***	93.97	86.79***
Dual licensure	0.57	4.77***	0.89	6.34***	4.3	8.2***
Lateral/Provisional license	6.73	5.37***	7.25	5.51***	3.84	4.40
Experience	12.31	11.87***	12.33	12.10***	11.13	10.92
Female	79.7	86.6***	90.51	91.59***	94.04	91.38***
White	85.1	82.8***	85.02	82.15***	87.01	84.26***
Asian	0.73	0.60**	0.59	0.33***	0.40	0.42
Black	11.79	12.90***	13.93	12.41	10.21	12.60*
Hispanic	0.16	0.66***	0.65	0.61	0.33	0.84**
American Indian	0.38	1.18***	0.22	1.07***	0.60	0.29**
Observations	*18,106*	*235,656*	*20,393*	*232,958*	*33,581*	*1,509*

***p < 0.01, **p < 0.05, and *p < 0.1 refer to mean-difference t-tests between cotaught and non-cotaught classrooms for each subject. The values in the table represent percentages, except for teacher experience, which is an average. Observations are the student-year level.

Table 3. Student Characteristics by Classroom Type (Inclusive vs Self-Contained)

	Classroom Type					
	Single Subject: Math		**Single Subject: ELA**		**Multi-subject**	
	Inclusive	Self-contained	Inclusive	Self-contained	Inclusive	Self-contained
Math score (std)	-0.720	-1.341***	-0.726	-1.124***	-0.574	-1.283***
ELA score (std)	-0.836	-1.313***	-0.828	-1.334***	-0.664	-1.298***
Learning Disability	52.51	37.38***	51.31	53.07***	45.49	32.60***
Autistic	3.47	3.57***	3.60	2.73***	3.75	7.72***
Behaviorally/Emo-tionally Disabled	3.63	14.03***	3.71	10.88***	3.42	23.38***
Speech-Language Impaired	15.80	0.47***	16.28	0.60***	20.51	0.67***
Other Health Impaired	20.17	31.53***	20.52	23.29***	22.91	23.79
Low-incidence Disabilities	3.47	7.95***	3.59	6.15***	3.16	5.77***
Female	32.78	31.30***	32.98	28.11***	31.86	23.22***
White	49.38	42.62***	49.39	41.79***	43.78	30.90***
Asian	0.76	0.30***	0.76	0.39***	0.92	0.46**
Black	25.03	29.94***	25.19	28.82***	22.18	32.96***
Hispanic	8.91	5.73***	8.87	7.52***	7.07	7.36
American Indian	1.57	2.97***	1.39	4.60***	0.41	0.88***
Multiracial	3.27	3.38	3.32	3.31	3.54	3.91
Observations	*241,292*	*12,470*	*235,875*	*17,476*	*33,148*	*1,942*

***p < 0.01, **p < 0.05, and *p < 0.1 refer to mean-difference t-tests between inclusive and self-contained classrooms for each subject. The values in the table represent percentages, except for math and ELA standardized scores, which are averages. Observations are the student-year level.

Table 4. Student Characteristics by Classroom Type (Co-taught vs Not Co-taught)

	Classroom Type					
	Single Subject: Math		**Single Subject: ELA**		**Multi-subject**	
	Co-taught	Not Co-taught	Co-taught	Not Co-taught	Co-taught	Not Co-taught
Math score (std)	-0.850	-0.741***	-0.775	-0.751***	-0.688	-0.609***
ELA score (std)	-0.945	-0.854***	-0.885	-0.859***	-0.862	-0.691***
Learning Disability	58.29	51.26***	59.76	50.70***	50.36	44.53***
Autistic	3.53	2.79***	3.11	3.58***	3.78	3.98
Behaviorally/Emot-ionally Disabled	3.87	4.16**	3.66	4.25***	2.98	4.59***
Speech-Language Impaired	3.68	15.92***	4.18	16.16***	17.50	19.50*
Other Health Impaired	27.34	20.22***	25.26	20.31***	21.94	23.00
Low-incidence Disabilities	3.39	3.71**	3.37	3.80***	2.45	3.34*
Female	34.57	32.56***	33.87	32.54***	31.28	31.39
White	51.65	48.85***	52.99	48.50***	40.95	43.16*
Asian	0.57	0.75***	0.50	0.75***	0.40	0.92**
Black	25.20	25.27	23.47	25.61***	24.45	22.70
Hispanic	9.18	8.73**	8.98	8.76	8.15	7.04
American Indian	0.79	1.71***	1.69	0.78***	0.40	0.43
Multiracial	3.50	3.26***	3.32	3.32	3.58	3.58
Observations	*18,106*	*235,656*	*20,393*	*232,958*	*33,581*	*1,509*

***p < 0.01, **p < 0.05, and *p < 0.1 refer to mean-difference t-tests between cotaught and non-cotaught classrooms for each subject. The values in the table represent percentages, except for math and ELA standardized scores, which are averages. Observations are the student-year level.

Table 5. Math Achievement for All Classrooms and by Classroom Type

	All Classrooms		Inclusive Co-taught	Inclusive Not Co-taught	Self-contained
	(1)	(2)	(3)	(4)	(5)
Self-contained classroom	-0.022*	-0.020			
	(0.013)	(0.015)			
Co-taught classroom	0.017**	0.016*			
	(0.009)	(0.009)			
Teacher Qualifications					
Advanced degree		0.002	-0.004	0.002	-0.034
		(0.004)	(0.026)	(0.005)	(0.045)
Lateral/Provisional license		-0.012	0.151***	-0.018*	0.174
		(0.009)	(0.044)	(0.01)	(0.130)
Special education license		0.0038	0.178***	-0.009	0.160
		(0.010)	(0.050)	(0.011)	(0.130)
Dual license		-0.019*	0.016	-0.002	0.144
		(0.011)	(0.232)	(0.013)	(0.129)
1-3 years experience		0.052***	0.0438	0.050***	-0.038
		(0.00986)	(0.0736)	(0.0104)	(0.103)
4-6 years experience		0.063***	-0.015	0.067***	0.054
		(0.010)	(0.08)	(0.01)	(0.105)
7-11 years experience		0.061***	0.0300	0.064***	-0.034
		(0.010)	(0.073)	(0.010)	(0.102)
12-16 years experience		0.063***	0.086	0.065***	-0.013
		(0.010)	(0.075)	(0.011)	(0.122)
17-25 years experience		0.072***	0.0796	0.0714***	0.00871
		(0.010)	(0.077)	(0.011)	(0.112)
>25 years experience		0.050***	0.067	0.052***	-0.038
		(0.011)	(0.080)	(0.012)	(0.118)
Teacher Demographics	No	Yes	Yes	Yes	Yes
Student Characteristics	Yes	Yes	Yes	Yes	Yes
Classroom Controls	Yes	Yes	Yes	Yes	Yes
Student FE	Yes	Yes	Yes	Yes	Yes
Year, School, Grade FE	Yes	Yes	Yes	Yes	Yes
Clustered standard errors	Yes	Yes	Yes	Yes	Yes
Observations	157,537	157,484	5,233	131,481	3,961
R-squared	0.851	0.851	0.837	0.861	0.818

***p < 0.01, **p < 0.05, and *p < 0.1. All models control for students' lagged classroom test scores, testing accommodations, classroom share of SWDs, and classroom size.

Table 6. Reading Achievement for All Classrooms and by Classroom Type

	All Classrooms		Inclusive Co-taught	Inclusive Not Co-taught	Self-contained
	(1)	(2)	(3)	(4)	(5)
Self-contained classroom	-0.030***	-0.026**			
	(0.011)	(0.012)			
Co-taught classroom	0.013*	0.012			
	(0.007)	(0.007)			
Teacher Qualifications					
Advanced degree		0.002	-0.008	-0.002	-0.010
		(0.004)	(0.020)	(0.005)	(0.043)
Lateral/Provisional license		-0.002	0.030	0.006	0.043
		(0.008)	(0.040)	(0.010)	(0.106)
Special education license		-0.011	0.022	-0.005	0.192**
		(0.008)	(0.043)	(0.010)	(0.097)
Dual license		-0.004	0.206	-0.007	0.172*
		(0.010)	(0.135)	(0.012)	(0.099)
1-3 years experience		0.022**	-0.042	0.017	0.080
		(0.010)	(0.046)	(0.011)	(0.076)
4-6 years experience		0.028***	-0.0303	0.032***	0.071
		(0.010)	(0.048)	(0.011)	(0.088)
7-11 years experience		0.029***	-0.021	0.031***	0.083
		(0.010)	(0.045)	(0.012)	(0.080)
12-16 years experience		0.0405***	-0.0241	0.045***	0.109
		(0.010)	(0.046)	(0.011)	(0.094)
17-25 years experience		0.043***	-0.003	0.042***	0.084
		(0.010)	(0.047)	(0.011)	(0.092)
>25 years experience		0.044***	0.025	0.048***	0.158*
		(0.011)	(0.047)	(0.012)	(0.088)
Teacher Demographics	No	Yes	Yes	Yes	Yes
Student Characteristics	Yes	Yes	Yes	Yes	Yes
Classroom Controls	Yes	Yes	Yes	Yes	Yes
Student FE	Yes	Yes	Yes	Yes	Yes
Year, School, Grade FE	Yes	Yes	Yes	Yes	Yes
Clustered standard errors	Yes	Yes	Yes	Yes	Yes
Observations	145,017	144,949	5,938	114,794	5,079
R-squared	0.864	0.864	0.874	0.873	0.858

***p < 0.01, **p < 0.05, and *p < 0.1. All models control for students' lagged classroom test scores, testing accommodations, classroom share of SWDs, and classroom size.

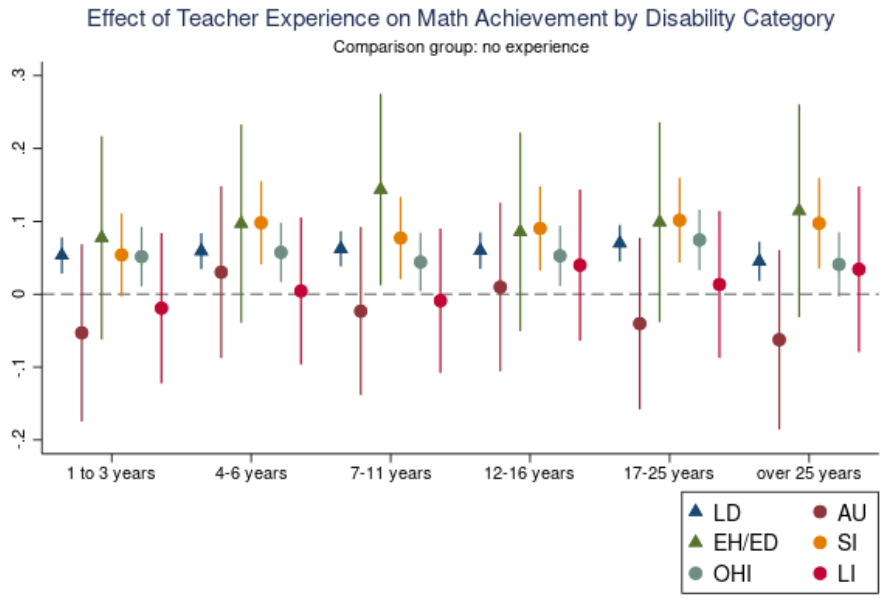

Figure 1. Math Achievement by Disability Category

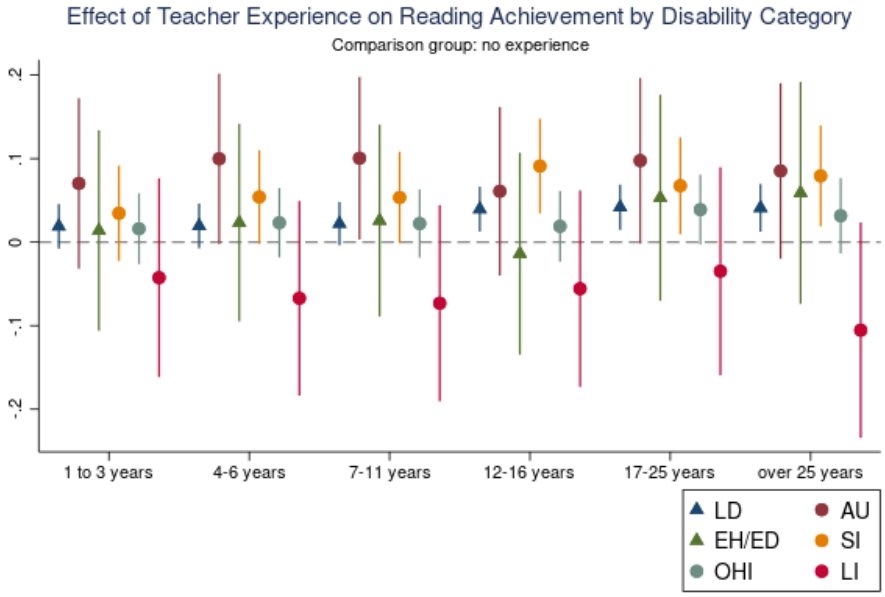

Figure 2. ELA Achievement by Disability Category

Endnotes

[1] The low-incidence disability categories include: intellectually disabled, deaf-blind, hearing impaired, orthopedically impaired, traumatic brain injured, visually impaired, educable mentally disabled, multi-handicapped, trainable mentally disabled, severely/profoundly mentally disabled, and developmentally delayed.

[2] Unlike Feng and Sass (2013), this approach does not allow students to have both general education teachers and special education teachers in the same subject simultaneously in the same year due to data matching constraints.

[3] In the North Carolina data, some classrooms may have two or more personnel formally classified as teachers assigned to the same classroom. This might be due to errors in classifying co-taught classrooms. However, since I cannot identify the role of the other teachers assigned within the classroom, I exclude these classrooms and only consider the classrooms which have one teacher and one co-teacher, based on formally defined job assignment classifications within the North Carolina data. This is in line with the primary measure of co-taught classrooms by Jones and Winters (2022).

Appendix

Table 1A. Math Achievement for All Classrooms by Disability Type

	LD	AU	EH/ED	SI	OH	LI
Self-contained classroom	-0.027	-0.021	0.064	-0.151	-0.043*	0.069
	(0.020)	(0.073)	(0.059)	-0.178	(0.024)	(0.106)
Co-taught classroom	0.017*	-0.012	0.019	0.019	0.014	-0.016
	(0.010)	(0.044)	(0.050)	-0.038	(0.015)	(0.046)
Teacher Qualifications						
Advanced degree	0.0054	0.016	-0.033	0.0004	-0.001	0.045*
	(0.005)	(0.021)	(0.025)	(0.012)	(0.008)	(0.024)
Lateral or provisional license	-0.008	-0.015	-0.050	-0.025	-0.026	0.002
	(0.012)	(0.044)	(0.043)	(0.0325)	(0.0172)	(0.0502)
Special education license	0.0105	-0.0769	-0.0679	0.00829	0.0134	-0.108*
	(0.013)	(0.050)	(0.046)	(0.051)	(0.018)	(0.057)
Dual license	-0.005	-0.007	-0.093*	0.007	-0.032	-0.126*
	(0.015)	(0.054)	(0.054)	(0.041)	(0.021)	(0.075)
1-3 years experience	0.053***	-0.053	0.077	0.054*	0.052**	-0.019
	(0.013)	(0.062)	(0.071)	(0.029)	(0.021)	(0.053)
4-6 years experience	0.059***	0.030	0.097	0.098***	0.057***	0.004
	(0.013)	(0.060)	(0.069)	(0.029)	(0.021)	(0.052)
7-11 years experience	0.062***	-0.023	0.144**	0.077***	0.044**	-0.0089
	(0.012)	(0.059)	(0.067)	(0.029)	(0.020)	(0.051)
12-16 years experience	0.060***	0.010	0.09	0.090***	0.053**	0.040
	(0.013)	(0.059)	(0.070)	(0.030)	(0.021)	(0.053)
17-25 years experience	0.070***	-0.040	0.099	0.102***	0.075***	0.013
	(0.013)	(0.060)	(0.070)	(0.030)	(0.021)	(0.052)
>25 years experience	0.045***	-0.063	0.114	0.097***	0.041*	0.034
	(0.014)	(0.063)	(0.074)	(0.032)	(0.023)	(0.058)
Teacher Demographics	Yes	Yes	Yes	Yes	Yes	Yes
Student Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Classroom Controls	Yes	Yes	Yes	Yes	Yes	Yes
Student FE	Yes	Yes	Yes	Yes	Yes	Yes
Year, School, Grade FE	Yes	Yes	Yes	Yes	Yes	Yes
Clustered standard errors	Yes	Yes	Yes	Yes	Yes	Yes
Observations	86,267	5,332	5,565	14897	34,006	3,955
R-squared	0.838	0.911	0.869	0.921	0.837	0.917

***p < 0.01, **p < 0.05, and *p < 0.1 Disability Categories: Autistic (AU), specific learning disabled (LD), behaviorally/emotionally disabled (EH/ED), speech-language impaired (SI), other health impaired (OH), and low-incidence disabilities (LI). All models control for students' lagged classroom test scores, testing accommodations, classroom share of SWDs, and classroom size.

Table 2A. Reading Achievement for All Classrooms by Disability Type

	LD	AU	EH/ED	SI	OH	LI
Self-contained classroom	-0.035**	-0.044	0.045	-0.031	-0.020	0.006
	(0.017)	(0.060)	(0.055)	(0.092)	(0.022)	(0.084)
Co-taught classroom	0.011	0.029	0.049	0.016	0.015	-0.010
	(0.010)	(0.038)	(0.049)	(0.035)	(0.015)	(0.044)
Advanced degree	0.001	0.025	-0.003	0.010	-0.012	0.030
	(0.006)	(0.020)	(0.028)	(0.012)	(0.0085)	(0.025)
Lateral or provisional license	0.016	-0.002	-0.051	-0.044	-0.015	-0.042
	(0.011)	(0.048)	(0.052)	(0.030)	(0.017)	(0.054)
Special education license	0.008	0.015	-0.040	-0.056	-0.0088	-0.056
	(0.011)	(0.047)	(0.047)	(0.039)	(0.016)	(0.058)
Dual license	0.015	0.043	0.0034	-0.027	-0.026	-0.020
	(0.014)	(0.060)	(0.063)	(0.037)	(0.020)	(0.065)
1-3 years experience	0.020	0.070	0.014	0.035	0.016	-0.043
	(0.014)	(0.052)	(0.061)	(0.029)	(0.022)	(0.061)
4-6 years experience	0.019	0.100*	0.023	0.054*	0.023	-0.067
	(0.014)	(0.052)	(0.060)	(0.029)	(0.021)	(0.059)
7-11 years experience	0.022*	0.100**	0.026	0.053*	0.022	-0.073
	(0.013)	(0.050)	(0.059)	(0.028)	(0.021)	(0.060)
12-16 years experience	0.039***	0.061	-0.014	0.091***	0.019	-0.056
	(0.014)	(0.051)	(0.062)	(0.030)	(0.022)	(0.060)
17-25 years experience	0.042***	0.098*	0.053	0.068**	0.039*	-0.035
	(0.014)	(0.051)	(0.063)	(0.030)	(0.021)	(0.063)
>25 years experience	0.041***	0.085	0.059	0.079**	0.032	-0.105
	(0.015)	(0.054)	(0.068)	(0.031)	(0.023)	(0.066)
Teacher Demographics	Yes	Yes	Yes	Yes	Yes	Yes
Student Characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Classroom Controls	Yes	Yes	Yes	Yes	Yes	Yes
Student FE	Yes	Yes	Yes	Yes	Yes	Yes
Year, School, Grade FE	Yes	Yes	Yes	Yes	Yes	Yes
Clustered standard errors	Yes	Yes	Yes	Yes	Yes	Yes
Observations	86,267	5,332	5,565	14,897	34,006	3,955
R-squared	0.838	0.911	0.869	0.921	0.837	0.917

***p < 0.01, **p < 0.05, and *p < 0.1. Disability Categories: Autistic (AU), specific learning disabled (LD), behaviorally/emotionally disabled (EH/ED), speech-language impaired (SI), other health impaired (OH), and low-incidence disabilities (LI). All models control for students' lagged classroom test scores, testing accommodations, classroom share of SWDs, and classroom size.

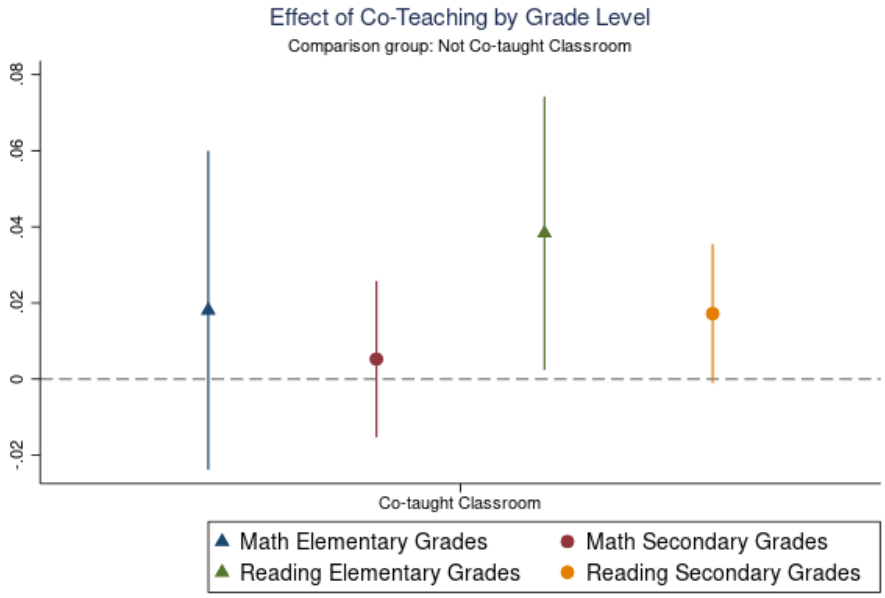

Figure 1A. Effect of Co-Teaching on Student Achievement by Grade Level

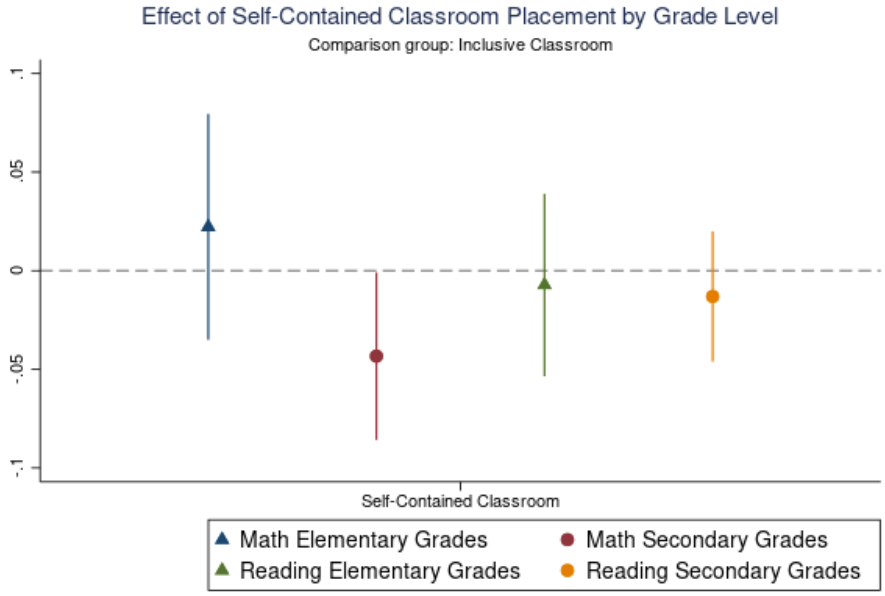

Figure 2A. Effect of Self-Contained Classroom Placement by Grade Level