Annenberg Institute
BROWN UNIVERSITY

EdWorkingPaper No. 24-1077

Did Mathematics Achievement Gaps for Students with Disabilities Widen after the Introduction of the Common Core and its Aligned Assessments?

Cassandra Guarino
University of California, Riverside

Anna Bargagliotti
Loyola Marymount University

Tom Smith
University of California, Davis

Hana Kang
University of Colorado, Colorado Springs

Yiwang Li
University of California, Riverside

This study addresses the important yet underexplored question of whether the Common Core State Standards in Mathematics, which emphasize critical thinking and problem-solving, as well as the computer-based assessments aligned with the Common Core, have facilitated or hindered learning for students with disabilities. By analyzing administrative data from a large county in California, we track mathematics achievement trends before and after the implementation of the Common Core. Our findings show a significant widening of the achievement disparity in mathematics between students with and without disabilities, suggesting that the Common Core and computerized assessments disproportionately affected students with disabilities.

VERSION: November 2024

Suggested citation: Guarino, Cassandra, Anna Bargagliotti, Yiwang Li, Tom Smith, and Hana Kang. (2024). Did Mathematics Achievement Gaps for Students with Disabilities Widen after the Introduction of the Common Core and its Aligned Assessments?. (EdWorkingPaper: 24 -1077). Retrieved from Annenberg Institute at Brown University: https://doi.org/10.26300/vd2m-fe68

Did Mathematics Achievement Gaps for Students with Disabilities Widen after the Introduction of the Common Core and its Aligned Assessments?

By Cassandra Guarino, Anna Bargagliotti, Tom Smith, Hana Kang, and Yiwang Li

Abstract

This study addresses the important yet underexplored question of whether the Common Core State Standards in Mathematics, which emphasize critical thinking and problem-solving, as well as the computer-based assessments aligned with the Common Core, have facilitated or hindered learning for students with disabilities. By analyzing administrative data from a large county in California, we track mathematics achievement trends before and after the implementation of the Common Core. Our findings show a significant widening of the achievement disparity in mathematics between students with and without disabilities, suggesting that the Common Core and computerized assessments disproportionately affected students with disabilities.

Introduction

The Common Core State Standards in Mathematics (CCSSM), released in 2009 by the National Governors Association and the Council of Chief State School Officers, introduced new rigorous standards for K-12 mathematics that emphasized problem solving and flexible approaches to mathematical thinking with the goal of preparing all students to be college and career ready upon completing their high school education.

A critical question that has yet to be explored is whether changes introduced by the CCSSM facilitated mathematical learning for all types of learners, particularly students with disabilities. These students, which we shall refer to by the acronym SWDs, represent between 12 and 14% of the overall public school student population and present a variety of diagnoses (National Center for Education Statistics, n.d.). Achievement gaps in mathematics between students with and without disabilities have historically been high, but little is known about whether these gaps have decreased or increased after the introduction of the CCSSM.

The standards do not provide curricular or pedagogical support and leave instructional practices regarding how they should be taught to the discretion of local educators (Murphy & Haller, 2015). However, their new requirements for mathematical learning have likely influenced mathematics instruction in significant ways. After introducing new standards, two new assessments were developed to align with the CCSSM. These were the Smarter Balanced Assessment Consortium (SBAC) and the Partnership for Assessment of Readiness for College and Careers (PARCC). Initially, most states adopted and administered one or the other of the new assessment systems.[1] The Common Core-aligned assessments in mathematics were delivered via computer, utilized adaptive testing methods, and were designed to capture the content covered in the CCSSM and test students' mathematical reasoning abilities. The new tests may also have significantly influenced the way mathematics is taught.

This study uses administrative data from the population of public school students in 17 districts in Riverside County in California over a decade—2009 to 2019. California schools transitioned to the new standards and implemented the SBAC around mid-decade; thus, the period covered by our study provides an ideal context for exploring pre- and post-Common Core and SBAC changes in the test-score gap between SWDs and non-SWDs. Moreover, our study traces achievement gaps up to the year just prior to the pandemic, thus pandemic factors play no role in the patterns we see. Our study answers the following research questions: How has mathematics achievement differed for students with different types of disabilities versus those without disabilities? Did gaps in achievement between SWDs and non-SWDs change after the introduction of the Common Core and SBAC?

Background and Literature

Types of Disabilities: More than three-quarters of a million students in California PreK-12 public schools have a diagnosed disability. SWDs represented approximately 12% of all students in the 2018-19 academic year,[2] comprised of students classified under 13 different types of diagnoses used by the California Department of Education. The disability classifications and their prevalence are shown in Figure 1.[3] As shown in the figure, the classifications of Specific Learning Disabilities (SLD)—300,295 students, Speech or Language Impairment (SLI)—164,698 students, Autism (AUT)—120,095 students, and those with Other Health Impairments (OHI)—104,792 students, occur with high frequency. In contrast, disabilities like deaf-blindness, hearing impairment, visual impairment, traumatic brain injury, and multiple disabilities have a low incidence.

[Insert Figure 1 here]

Autism was once a low-incidence disability, but the category has grown over time. Nationally, autism diagnoses rose from 1.5% of students with disabilities in 2000 to 11% in 2020.[4] Attention-deficit hyperactivity disorder (ADHD), another high-growth disability category, is largely subsumed under OHI[5] (Stichter et al., 2008).[6] This category grew from 4.8% in 2000 to 15% in 2020, potentially due to the increased awareness and diagnosis of ADHD. All other categories of disabilities either decreased over time or remained consistent.

Disability distributions vary with age and grade. SLI, for example, comprising conditions like stuttering or other speech impediments, is usually diagnosed early, responds to therapy, and is often outgrown over time, although evidence suggests that academic difficulties can persist for years beyond the removal of the diagnosis (Harrison et al., 2009). Figure 2 shows the distribution of disability categories by age. The figure shows the SLI diagnosis category clustered in preschool and early grades. In contrast, SLD is primarily diagnosed when students perform poorly on performance on tests, and it increases with grade until it levels off during high school.

[Insert Figure 2 here]

We group low-incidence disabilities—that is, those listed from Intellectual Disability on downward in Figure 1—together to facilitate the reading of graphics. However, given the large proportion of SWDs in high-incidence categories, we track SLD, SLI, AUT, and OHI separately.

SWDs and Mathematics Achievement: The academic achievement of SWDs has long been a focus of concern and policy (Schulte & Stevens, 2015; Stevens et al., 2015; Wagner et al., 2006). Policies such as No Child Left Behind (NCLB) required the reporting of achievement for SWDs and included them in the goal of reaching adequate yearly progress for all students (NCLB, 2002). Districts could only be exempt from testing students with the most severe disabilities, although accommodations were made for others. As benchmarks for the percentage of students having to score at the proficiency level rose as part of NCLB,[7] students identified with disabilities demonstrated particular difficulty meeting the "adequate yearly progress" required by the policy (Eckes & Swado, 2009).

SWDs, taken as a group, have experienced low mathematics performance (Judge & Watson, 2011; Stevens et al., 2015), predating the CCSSM. Results from the NAEP assessments in 2005 showed that 44% of SWDs in fourth grade did not meet basic mathematics levels compared with 17% of students without disabilities (NAEP, 2005). In eighth grade, these differences were even more pronounced, with 69% of SWDs scoring below the basic level but only 28% of non-SWDs scoring below the basic level. This pattern persisted in NAEP 2009—41% of fourth graders with disabilities were at below basic levels in mathematics compared with 16% of fourth graders without disabilities. In eighth grade, 64% of SWDs scored below a basic level of proficiency compared with 24% of non-SWDs (NAEP, 2009). Clearly, there were large gaps in mathematics proficiency between SWDs and those without before the implementation of Common Core.

Some studies unpack the mathematics achievement of students with specific disabilities. For example, Mayes et al. (2000) and Shalev et al. (2001) report that higher rates of mathematical difficulty are present in students with ADHD (~13%) compared with the general population (~7%) and about 25% of students with mathematical difficulties have ADHD. Wei et al. (2013) studied mathematics achievement longitudinally for students from 7-17 years old using a large nationally representative data set and found that SWDs had lower achievement and slower growth in mathematics achievement throughout elementary school compared with their peers. At the secondary level, growth rates in achievement slowed for all types of students, and growth rates in achievement for SWDs, on average, were on par with the general population of students. While students with speech or visual impairments had the highest mathematics achievement among students with disabilities, those with multiple disabilities, intellectual disabilities, or autism had lower mathematics achievement throughout all grades.

Numerous studies discuss the pervasiveness of low mathematics achievement for students with specific high-incidence disabilities (e.g., Carter et al., 2005; Maston et al., 2003; Stevens et al., 2015). Zentall (2007) notes that students with ADHD often underachieve, and discrepancies between IQ scores and achievement increase with age (see also Lucangeli & Cabrele, 2006 for a review of the literature on ADHD and mathematical difficulties). Students with speech and language impairments have also been shown to score significantly lower on assessments than the general population (Conti-Ramsden et al., 2002; Durkin et al., 2013).

SWDs, Sources of Mathematical Difficulties, and the CCSSM

Research focusing on students with mathematical difficulties sheds light on the sources of difficulty experienced by some students. Students are considered to exhibit mathematical difficulties when they demonstrate poor computational skills and conceptual understanding, poor strategy selection for problem solving, poor memory, and impaired self-monitoring and self-regulation during problem solving (Geary, 2004; Geary et al., 2000). Exhibiting mathematical difficulties often coexists with a disability diagnosis but can also be independent (Wei et al., 2013; Zentall & Ferkis, 1993).

Specific mathematical concepts have been identified as particularly challenging for SWDs. For example, early counting and magnitude of quantities, telling time, conceptual understanding of number combinations and solving multi-digit problems, and problem solving have all been found to present difficulty (e.g., Fuchs & Fuchs, 2002; Kearns et al., 2011; Miller & Mercer, 1997; Montague, 2008). Word problems also are challenging for SWDs due to the reading comprehension skills needed to solve such problems (e.g., Parmar et al., 1996; Jitendra et al., 1998; Xin & Jitendra, 1999). For example, Bryant et al. (2000) show that mathematical tasks related to problem solving and word problems prove particularly difficult to students with SLD, particularly the multi-step nature of the problems and understanding the syntax. With the implementation of the CCSSM and its emphasis on word problems, problem solving, and conceptual understanding over memorization and procedures (Porter et al., 2011), SWDs likely faced greater difficulties meeting proficiency standards than before. Powell et al. (2013) noted that the implementation of the CCSSM brought forth several concerns about SWD's ability to meet grade-level standards. To mitigate concerns, they suggest a teaching approach to the standards that focuses on building up a standard on a "mountain." While a standard may be the top of the mountain, teachers provide SWDs with a schema to climb the mountain by working through foundational skills related to the standard. Some studies have suggested that choosing appropriate problems Stephan and Smith (2012), having co-teachers present (King-Sears, et al. 2021; Jones & Winters 2024), and engaging the students actively in solving a problem (e.g. Alghamdi, A., Jitendra, A. K., & Lein, A. E., 2020; Klang et al., 2021), can be viable approaches for teaching SWDs the standards.

SWDs and Computerized Testing: Since the implementation of the CCSSM, computer-based assessments have increasingly been used across the United States. The most widely used standardized tests aligned with the CCSSM—the SBAC and the PARCC—are computer-based. Previous studies have shown that testing modalities can impact student performance (Katsiyannis et al., 2007; Thurlow et al., 2010). Students with access to and familiarity with computer-based interfaces may perform better on computerized tests than those without (Data Recognition Corporation [DRC], 2007). Student performance may also be affected by differences in screen size and resolution or settings on operating systems and browsers (Bridgeman et al., 2003).

Research suggests that computer-based testing may hinder the performance of SWDs (Kamei-Hannan, 2008; Thurlow et al., 2010). SWDs are required to take the CCSSM-aligned assessments on a computer like other students, and whether they have test accommodations (Helwig & Tindal, 2003) is likely to influence their performance.[8] The SBAC does offer a set of embedded accommodations (e.g., braille, text-to-speech, closed captioning) and non-embedded accommodations such as calculators or read aloud (Smarter Balanced, 2022). Whether these supports are put in place for SWDs on the SBAC test is left to the team of individuals who put together students' Individualized Education Plans (IEPs), which determines whether an accommodation is necessary on a case-by-case basis. Studies also show how the use of accommodations for testing is prevalent for SWDs (Cox et al., 2006). Specific to the SBAC assessment, Abedi and Ewers (2013) describe criteria that schools may use to determine whether SWDs can have accommodations for the test. If an accommodation is to be used, it must have evidence of its validity, effectiveness, impact, relevance, and feasibility.

Students with low reading proficiency and high mathematics proficiency may benefit from read-aloud or text-to-speech accommodations during a mathematics test (Fuchs et al., 2000; Wei, 2024). For example, Calhoon et al. (2000) show that when secondary SWDs have the accommodation of a reader on a computer-based test, they perform significantly better than if they did not. Flowers et al. (2011), however, show SWDs taking paper-and-pencil assessments with read-aloud accommodations received higher mean scores on mathematics tests than those using computer-based-assessments with read-aloud accommodations by about an average effect size of .25. This same pattern persisted across grade levels in their study. Specific computer systems tailored for SWDs do exist, but they are expensive, and teachers need to be supported and trained in their use. Such barriers (e.g., cost, teacher training, and access in classrooms) may hamper the integration of computer-based instruction to meet the needs of diverse student populations (Hasselbring & Glaser, 2000; Martinez, 2011; Tyson, 2015).

In summary, our review of the literature suggests that CCSSM may present challenges for SWDs and that computerized administrations of the SBAC without sufficient accommodations may further challenge their ability to show mathematical learning gains. Therefore, the change to the CCSSM and the new computerized testing regime during the 2009-2019 decade might be expected to produce a relative decline in test scores for SWDs versus non-SWDs and a widening of the achievement gap.

Data

Our data, provided by the Riverside County Office of Education (RCOE), span the entire 2008-09 to 2018-19 decade and include longitudinal student-level information on enrollment, demographics, education programs, and achievement for all students in grades three through eight as well as grade eleven. We obtained data on 17 districts in Riverside County.[9] A total of 1,408,400 observations and 508,532 unique students are included in the data set of students in the tested grades with complete test score data. Table 1 shows summary statistics for our data. To investigate generalizability, we compared demographic characteristics for the analytic sample from the 17 districts included in our study in 2019 with those from the entire state of California in 2019 and found very little difference other than a higher percentage of Hispanic/Latina/o/x students and EL students (and concomitant lower percentage of Asian and White students) in our sample versus the state as a whole (see Table 1). Throughout the time period covered by our data, approximately 60% of students are categorized as Hispanic/Latina/o/x. The poverty level is high, with about 59% of students eligible for free-and-reduced-price meals (FRPM).

[Insert Table 1 here]

Disability Variables: As noted above, disability diagnoses in California consist of the 13 categories listed in Figure 1. About 11% of students in our analytic sample for the decade are classified as students with disabilities.[10] Table 1 shows the distribution of students across the disability categories for the tested students in Riverside County in our data. In our table, the low-incidence disabilities, which comprise deaf-blindness, traumatic brain injury, intellectual disability, multiple disabilities, orthopedic impairment, and visual impairment, are aggregated in the low-incidence category, and collectively, include around 1% of students. The largest category within the high incidence disabilities is SLD, which is 6%, followed by SLI at 2%.

Test Score Variables

We use standardized mathematics tests administered before and after the introduction of the CCSSM. California used the Standardized Testing and Reporting Program (STAR) testing regime from 1998-99 to 2012-13, then moved away from the STAR and adopted the California Assessment of Student Performance and Progress (CAASPP) testing regime in 2014-15. The CAASPP consists primarily of the Smarter Balanced Summative Assessments, which we refer to in this paper as the SBAC—the more generic name for these assessments.[11]

Our study uses test score data from 2008-09 to 2011-12 for the STAR (pre-SBAC) years[12] and data from 2014-15 to 2018-19 for the CAASPP (post-SBAC) years. We exclude the two years, 2012-13 and 2013-14, between the complete transition from one testing regime to the other. Thus, we used four pre-SBAC years and five post-SBAC years.

The 2013-14 school year was excluded because it was a gap year where no testing took place, and this is when California transitioned from STAR to CAASPP. The 2012-13 school year was the last year the STAR tests were administered, but several districts in our sample did not submit their testing data for the 2012-13 school year to RCOE, thus we also excluded that year in order to maintain complete observations from the 17 districts in the sample across the decade. Below, we discuss both testing regimes in greater detail.

STAR Assessment Regime (2008-09 to 2011-12 in our data): The STAR testing regime consisted primarily of the California Standards Test (CST)—a paper and pencil test administered within a 21-day window that began ten days before and ended ten days after the day on which 85% of the instructional year was completed, generally between mid-March and mid-June.

In addition, two modified assessments—the California Modified Assessment (CMA) and the California Alternate Performance Assessment (CAPA)—were administered to a small subset of students with test-taking difficulties. The CMA was an alternate assessment to the CST for eligible students who had an IEP plan and met the CMA eligibility criteria. To be eligible for the CMA in a particular subject, the student must have scored Below Basic or Far Below Basic on the CST in a previous year. Once declared CMA eligible, a student would typically keep taking this assessment for the duration of their education.

The CAPA was designed for SWDs with the most significant cognitive disabilities who had an IEP plan but could not take either the CST or the CMA, even with accommodations. The questions on the CAPA were open-ended and were answered with assistance from teachers.

The first rows of Table 2 below show the percentages of SWDs included in the various types of STAR tests in mathematics over time. The table shows that the CST was, by far, the dominant test form, with only four to five percent of tested SWDs taking the CMA and fewer than one percent taking the CAPA.

[Insert Table 2 here]

CAASPP Assessment Regime (2014-15 to 2018-19 in our data): The CAASPP consists primarily of the SBAC. Districts could select their local testing window with a minimum window of 25 consecutive instructional days. They could be administered between the day of completion of 66% of a school's annual instructional days and the last day of school or July 15, whichever came first.

The SBAC has two components: Computer Adaptive Test (or non-PT) and Performance Task (PT). The non-PT part of the test is conducted via a digital device (such as a computer or tablet), which has the item types of selected response (multiple choice), technology-enhanced/enabled items, and short-constructed response. The PT part of the test is also carried out on a digital device, but students are asked to provide short answers with a scaffolding process. It is designed to assess the knowledge and skills of students in the specific grade levels for which it is intended, so it would not typically include content outside of those grades. However, the test may include questions that assess student understanding of concepts that are foundational to the material covered in the assessed grades and are taught in earlier grades.

The adaptive nature of the computerized SBAC assessment made a separate, modified exam like the CMA used in the prior STAR regime unnecessary. For students with the most significant cognitive disabilities, however, the CAASPP offered the California Alternative Assessment (CAA) as computer-based test. Embedded and non-embedded testing accommodations were available to SWDs with an IEP or Section 504 Plan in both the SBAC and CAA.

The last rows of Table 2 show the distribution of percentages of SWDs who took the SBAC and the CAA. In the CAASPP years, initially, everyone took the SBAC, but over time, the CAA was administered to close to one percent of SWDs (a similar percentage to those who took the CAPA in the STAR testing regime).

For our study, we excluded the small number of CAPA takers in the STAR years and CAA takers in the CAASPP years from our analyses because their tests were very different in terms of content, difficulty, and scale, resulting in the exclusion of about one percent of SWDs per year for most years.

The mathematics test score scales were different between STAR and CAASPP tests. The original scale scores of CSTs and CMA ranged from 150 to 600, whereas the scale scores of SBAC ranged from 2189 to 2862. Table 3 shows summary statistics for student achievement in the original scales for our analytic sample.[13]

[Insert Table 3 here]

To achieve similar within-year scales throughout the decade, we standardized test scores by year and grade, including CST and CMA in the STAR years and the SBAC only in the CAASPP years.

Methods

We analyzed patterns of average achievement for SWDs, different types of SWDs, and non-SWDs over the period under consideration and used graphical representations to display our results. To do this, we ran the equivalent[14] of the following cross-sectional student-level regression model for each separate year in the data and created plots of average achievement for SWDs and non-SWDs over time.

$$y_{ig} = \alpha + \overrightarrow{SWD}_{ig}\vec{\theta} + \gamma_g + \varepsilon_{ig} \qquad (1)$$

where y_{ig} is the within-grade standardized mathematics score for student i in grade g in the specified year, α is the intercept, SWD_{ig} is either a dichotomous variable indicating that the student is identified with a disability or, in most specifications, a vector of variables indicating different disability categories, γ_g is an indicator for the grade level of the student, and ε_{ig} is an error term representing the student's deviation from predicted average achievement. From the estimated equation, we plot predicted average achievement for SWDs (as a group or disaggregated) and non-SWDs for each year, controlling for nothing but grade level. We refer to this as our "unadjusted" model.

We also estimated the predicted average achievement after controlling for several factors that could influence achievement gaps because they are correlated with both achievement and disability status. For these analyses, we used the following specification:

$$y_{igs} = \alpha + \overrightarrow{SWD}_{igs}\vec{\theta} + \vec{x}_{igs}\vec{\beta} + \gamma_g + \sigma_s + \varepsilon_{igs} \qquad (2)$$

where y_{igs} is within-grade standardized mathematics score for student i in grade g and school s in the specified year, SWD_{igs} is as before, the x vector contains indicators for gender, race/ethnicity, English learner (EL), free-and-reduced-price meal eligibility (FRPM), parent education, country of birth, and language spoken at home, γ_g is the grade-level indicator, and σ_s is an indicator for the student's school (i.e., a school fixed effect). We then obtain predicted average achievement for SWDs and non-SWDs for each year and plot these estimates from our "adjusted" model over time.[15] [16]

Results

Unadjusted Results: We first examine the unadjusted differences in average mathematics achievement over time between SWDs and non-SWDs (see Figure 3). Recall that our pre-CCSSM/SBAC period was all years preceding and including the 2011-2012 school year, and our post-CCSSM/SBAC period was all years including and following the 2014-2015 school year, since insufficient data were reported to RCOE in 2012-13 and no test was administered in 2013-14.

[Insert Figure 3 here]

Figure 3 shows a sharp increase —around half of a standard deviation—in the predicted achievement gap between SWDs and non-SWDs in the post-CCSSM period. Note that the standardization of test scores by grade and year produces a relatively flat line for non-SWDs because they represent the large majority of students taking the tests and thus have a mean close to zero. The sizeable drop in test scores for the SWDs indicates a substantial decrease in mathematics scores relative to the non-SWDs. The achievement disparities between the two groups of students were relatively stable prior to 2012 and then again after the gap widened in

2015. The SWD group is about a half standard deviation below the non-SWD group for all years before 2012, with the gap widening to almost a full standard deviation for all years post 2015.

Figure 4 breaks down the aggregate SWD category into subgroups. The steep decline relative to non-SWDs is evident for students in all disability categories, with the exception of SLI. This is not surprising, as there is generally no achievement-related or cognitive component related to the SLI diagnosis. The category of SLD, on the other hand, has the largest relative drop—to more than a standard deviation below the non-SWD group. The OHI and low-incidence groups have similar declines relative to non-SWDs—short of a standard deviation—while the AUT group hovers around ¾ of a standard deviation below non-SWDs for all years post-2015. Similarly to aggregate SWD trends, this graph shows that the gap post-2015 tends to hold steady.

[Insert Figure 4 here]

Because disability diagnoses tend to cluster in different grades, we also plotted achievement gaps between SWDs and non-SWDs by grade for the 2008-09 school year and the 2018-19 school year.

[Insert Figure 5 here]

Figure 5 shows the gaps by grade for the years 2009 on top and 2019 below. We clearly see larger gaps in the latter period. However, there is no discernable difference by grade within a year. Thus, shifts in the number of students with disabilities in particular grades are not driving the overall outcome.

Adjusted Results: To determine whether the pattern shown above is driven by changes over time in observable student characteristics that may be correlated with both disability status and achievement, we estimate predicted values of mathematics achievement over time after adjusting for all the control variables (gender, race/ethnicity, EL, FRPM, parent education, country of birth, language spoken at home, and school fixed effects) represented in equation (2) in the methods section above. The adjusted patterns are shown in Figures 6 and 7.

Our adjusted models show that the noticeable pattern of decline for SWDs relative to non-SWDs beginning in 2015 maintains after observed characteristics are controlled. The achievement gap shown in Figure 6 is slightly smaller than in the unadjusted model, shrinking slightly from half a standard deviation to between a quarter and half a standard deviation but remains wide. Figure 7 shows the widening gap is evident for all SWDs who were not categorized as SLI, as before in the unadjusted results.

[Insert Figure 6 here]

[Insert Figure 7 here]

Discussion

Several possible explanations might account for the pattern of post-Common Core/SBAC decline in relative mathematics achievement that we see for students with disabilities in Riverside County. We consider three broad categories of hypotheses: (1) shifts in the composition of students taking the achievement tests between the pre- and post-CCSSM periods, (2) changes in the modality in which the assessments were delivered, and (3) changes in the content of the assessments due to the requirements of the Common Core, which may simply be more difficult for SWDs than non-SWDs.

We begin by addressing the issue of shifts in the characteristics of test-takers because we have data that allow us to confirm or rule out this hypothesis. First, we examine whether identification rates shifted over time. If, say, the percentage of students identified with disabilities decreased over time, it might indicate that lower-scoring students became more concentrated in this group—leading to a widening of the gap because SWDs make up a relatively smaller proportion of all students.

Table 4 shows the percentage of students identified with disabilities. The table shows that the overall identification rates increased nearly 5% over the course of the decade. Except for SLI, the increases occurred across the board in high-incidence diagnoses and were greatest for OHI and SLD. However, these percentages rose fairly steadily throughout the decade and therefore, were not likely, in themselves, to produce the sharp increase in the achievement gap that occurred immediately following the introduction of the CAASPP.

[Insert Table 4 here]

In addition to issues surrounding identification, policies related to test exclusion and accommodation may have been relevant to the test score drop. If, for example, larger shares of special needs students were allowed to opt out of testing in the pre-CCSSM time period, we might see a decline in SWD test scores once students with the same disability diagnoses were reintegrated into the test-taking population. To investigate this hypothesis, we looked at the percentages of students within various SWD and non-SWD categories over time who participated in testing.[17] These are shown in Table 5.

[Insert Table 5 here]

The table shows that in most years, more than 90% of students participated in testing, except for 2009, in which lower percentages of SWDs participated.[18] SWD participation generally increased over time, with no discontinuity pre- and post-CCSSM/SBAC. Thus, it seems unlikely that test score participation was a factor in the achievement gap patterns we see.

Our second set of hypotheses relates to shifts in characteristics of the Common Core-aligned assessment modalities that may have played an important role in driving the increase in the mathematics achievement gap for SWDs. The testing interface changed pre-and-post CCSSM from the paper and pencil STAR tests to the computer-assisted and adaptive SBAC tests. It is possible that the computerized test interface presented more challenges for SWDs than non-SWDs, as indicated in our review of the literature. Furthermore, the switch to computerized testing assessment changed how test questions were presented to students. For example, students were asked to present their thought processes, drag and drop, fill in the blanks, utilize interactive tools, explain their thought processes, etc. Such testing modalities represented a large change from prior paper and pencil simple multiple-choice tests. While accommodations could be made for SWDs for the SBAC test, as a site-based decision, the use of such accommodations depended, at least partially, on decisions by the IEP team.

We are unable to confirm or rule out the hypothesis that the change in testing modality caused greater difficulty for SWDs using our data, but we can investigate the use of accommodation strategies in our data. If the nature of accommodations changed over the decade to become less helpful to SWDs, that might also influence the patterns we see. However, upon investigation, we found the use of accommodations more prevalent in the CAASPP period than in the STAR period. Figure 8 shows the percentages of students in various disability and non-disability categories who received exam accommodations.

[Insert Figure 8 here]

As the figure shows, higher percentages of students used accommodations in the CAASPP period than in the earlier STAR period.[19] Nevertheless, despite the vigorous use of accommodations, the computerized testing interface may still have presented greater challenges for SWDs than non-SWDs, and the accommodations used might not have completely compensated for this.

The final explanation for the precipitous drops in the performance of SWDs relative to non-SWDs is related directly to the Common Core. The widening gap is consistent with what the research noted in our literature review might predict—namely, that the Common Core would present greater challenges for students with disabilities than for students without them. The word problems, open-ended questions, and focus on problem solving emphasized in the CCSSM are likely more difficult for SWDs than non-SWD students. With an increased focus on these problem types and emphasis on conceptual understanding, it is not surprising that achievement gaps have widened with the implementation of the CCSSM and SBAC for SWDs.

Limitations: The descriptive nature of our data imposes limitations and precludes the establishment of a causal relationship between the CCSSM or SBAC transition and the mathematics performance of students with disabilities relative to those without disabilities. In addition, the simultaneous adoption of CCSSM and SBAC without staggered timing resulted in an absence of variation necessary to disentangle the effects of CCSSM and SBAC in our data. Thus, while we have explored several hypotheses for the declines we observe and ruled out a few, we remain uncertain to what extent they can be attributed to SWDs acquiring mathematics skills differently or differentially encountering difficulties in the testing process.

Moreover, interruptions in and changes to instruction due to the COVID-19 pandemic have not yet permitted us to identify whether this decline was temporary or whether the mathematics learning of SWDs will increase as teachers adopt pedagogies that attend to their learning needs. The pandemic may also have impacted SWDs and non-SWDs differently. However, the patterns observed prior to the pandemic are likely to have persisted, possibly worsening with an increased reliance on technology post-COVID.

In addition, many states have recently adjusted their standards and frameworks (see for example, California Frameworks, Oregon State Standards, Georgia State Standards) to move away from the Common Core. However, while there has been a move away and push to adjust the Common Core to make the standards clearer, many fundamental parts of the CCSSM are still quite relevant. For example, the eight Mathematical Practices that describe the types of habits of mind students need to develop while doing mathematics, which were introduced by the CCSSM, are not only relevant but are the pillar of many reforms (GA DoE, 2021; TN DoE, 2021). Problem solving also remains an important focus of many state standards as are computerized state tests, thus suggesting that the results in this study are not only relevant but merit attention to ensure that SWD student gain the necessary support to thrive in current conditions.

Conclusion

Overall, our study has revealed a notable increase in the disparity in measured mathematics achievement for SWDs versus non-SWDs following the adoption of the Common Core and CAASPP testing regime. Given the limitations of our data, we are unable to pinpoint whether the standards themselves, the instructional approaches encouraged by the CCSSM, or the assessment approaches of the CAASPP were responsible for explaining the sharp increase in the achievement gap between SWDs and non-SWDs that we found post-CCSSM. It is likely that a combination of all these aspects of curricular change contributed to increased gaps. However, it would be prudent for policymakers and school administrators to consider how both these explanations may have played a role in producing the phenomenon we see.

Considering the standards themselves, the promotion of problem solving by the CCSSM is a means to expand rigor in mathematical thinking and reasoning to all students. For SWD students, however, teaching methods that allow them to successfully engage in problem solving must become routine practice in schools. As states begin to undergo the process of updating and rewriting their standards (e.g., Tennessee State Board of Education, n.d.), attention must be given to how SWDs can benefit from the increased rigor of the mathematics proposed. The literature suggests some approaches to teaching problem solving in the CCSSM in a way that SWDs can flourish (see e.g., Lein, Jitendra, & Harwell, 2020).

The literature suggests that to improve the mathematical understanding of SWDs, instruction and problem types need to be delivered in explicit ways using systematic approaches (Browder et al., 2012; Spooner et al., 2017). "Explicit instruction" in mathematics—characterized as demonstrating a step-by-step plan for problem solving or giving students a specific set of directions for a problem type that the students then subsequently implement on their own—has been shown to be particularly beneficial for SWDs (Fuchs & Fuchs, 2003; Gersten et al., 2001; Swanson & Hoskyn, 1998; Witzel et al., 2003; Saunders et al., 2013). Schema-based instruction for word problems (Fuchs et al., 2004; Fuchs, et al., 2008; Xin et al., 2005, Gagnon & Maccini, 2001; Van Garderen, 2007), computer-based explicit instruction (Burns et al., 2012), scaffolding (Baker et al., 2002), using heuristics (Gersten et al., 2009), and discussion prompts (Murphy & Marshall, 2015) can result in improvements for SWDs. While it seems clear that SWDs benefit from step-by-step, explicit instruction, it is unclear to what degree such instructional approaches have been adopted in the schools in our data during the adoption of the CCSSM and whether they would in fact be effective practices for helping SWDs solve problems on the SBAC.

It is an open question how computerized assessments can be improved to allow SWDs to demonstrate their learning. The exploration of ways to adapt assessment instruments and design accommodations to facilitate the testing of SWDS is an important direction for future research.

For example, Wei and Zhang (2024) find that the use of extended time by SWDs on digital math tests improved performance on such tests. A more structured instructional approach and an improved assessment approach could prove successful for SWD students while still maintaining the level of rigor put forth by the CCSSM.

The disparity in mathematics achievement between SWDs and non-SWDs that we have described is one the education community must focus on to better serve these children. Our study points to a disturbing pattern that policymakers and education leaders should take into consideration. Going forward, methods of teaching mathematics to SWDs and assessing their mathematical knowledge must address their unique needs.

References

Abedi, J., & Ewers, N. (2013). Accommodations for English language learners and students with disabilities: A research-based decision algorithm. *Smarter Balanced Assessment Consortium*.

Alghamdi, A., Jitendra, A. K., & Lein, A. E. (2020). Teaching students with mathematics disabilities to solve multiplication and division word problems: The role of schema-based instruction. *ZDM*, *52*(1), 125-137.

Baker, S., Gersten, S., & Scanlon, D. (2002). Procedural facilitators and cognitive strategies: Tools for unraveling the mysteries of comprehension and the writing process, and for providing meaningful access to the general curriculum. *Learning Disabilities Research and Practice*, *17*, 65–77.

Bridgeman, B., Lennon, M. L., & Jackenthal, A. (2003). Effects of screen size, screen resolution and display rate on computer-based test performance. *Applied Measurement in Education*, *16*, 191–205.

Browder, D. M., Jimenez, B. A., & Trela, K. (2012). Grade-aligned math instruction for secondary students with moderate intellectual disability. *Education and Training in Autism and Developmental Disabilities*, *47*(3), 373-388.

Bryant, D. P., Bryant, B. R., & Hammill, D. D. (2000). Characteristic behaviors of students with LD who have teacher-identified math weaknesses. *Journal of learning disabilities*, *33*(2), 168-177.

Burns, M. K., Kanive, R., & DeGrande, M. (2012). Effect of a computer-delivered math fact intervention as a supplemental intervention for math in third and fourth grades. *Remedial and Special Education, 33*(3), 184–191.

California Department of Education (n.d.) *STAR Data Files*. https://www.cde.ca.gov/re/pr/star-datarecordlayouts.asp

California Department of Education (2022a). *Adequate Yearly Progress (AYP)*. https://www.cde.ca.gov/re/pr/ayp.asp

California Department of Education (2022b). *AYP Data Files*. https://www.cde.ca.gov/re/pr/aypdatafiles.asp

Calhoon, M. B., Fuchs, L. S., & Hamlett, C. L. (2000). Effects of computer-based test accommodations on mathematics performance assessments for secondary students with learning disabilities. *Learning Disability Quarterly*, *23*(4), 271-282.

Carter, E. W., Wehby, J., Hughes, C., Johnson, S. M., Plank, D. R., Barton-Arwood, S. M., & Lunsford, L. B. (2005). Preparing adolescents with high-incidence disabilities for high-stakes testing with strategy instruction. *Preventing School Failure: Alternative Education for Children and Youth*, *49*(2), 55-62.

Coalition to Protect Our Public Schools (n.d.). *States leave Common Core SBAC and PARCC tests like rats deserting a sinking ship*. https://coalitiontoprotectourpublicschools.org/latest-news/states-leave-common-core-sbac-and-parcc-tests-like-rats-deserting-a-sinking-ship

Conti-Ramsden, G., Knox, E., Botting, N., & Simkin, Z. (2002). Focus on practice: Educational placements and National Curriculum Key Stage 2 test outcomes of children with a history of specific language impairment. *British Journal of Special Education*, *29*(2), 76-82.

Cox, L., Herner, J. G., Demczyk, M. J., & Nieberding, J. J. (2006). Provision of testing accommodations for students with disabilities on statewide assessments: Statistical links with participation and discipline rates. *Remedial and Special Education*, *27*(6), 346–354

Data Recognition Corporation (2007). Study on the feasibility and cost of converting the state assessment program to a computer-based or computer-adaptive format. http://eoc.sc.gov/NR/rdonlyres/CAEF9136-26CB-421D-80E3-D5B35B72CE76/5535/SCFeasibilityFinalReport.pdf.

Durkin, K., Mok, P. L., & Conti-Ramsden, G. (2013). Severity of specific language impairment predicts delayed development in number skills. *Frontiers in psychology*, *4*, 581.

Eckes, S. E., & Swando, J. (2009). Special education subgroups under NCLB: Issues to consider. *Teachers College Record*, 111(11), 2479–2504.

Flowers, C., Kim, D.-H., Lewis, P., & Davis, V. C. (2011). A comparison of computer-based testing and pencil-and-paper testing for students with a read-aloud accommodation. *Journal of Special Education Technology*, *26*(1), 1-12. https://doi.org/10.1177/016264341102600102

Fuchs, L. S., & Fuchs, D. (2002). Mathematical problem solving profiles of students with mathematics disabilities with and without comorbid reading disabilities. *Journal of learning disabilities*, *35*(6), 564-574.

Fuchs, L. S., & Fuchs, D. (2003). Enhancing the mathematical problem solving of students with mathematics disabilities. In H. L. Swanson, K. R. Harris, & S. Graham (Eds.), *Handbook of learning disabilities* (pp. 306–322). The Guilford Press.

Fuchs, L. S., Fuchs, D., Eaton, S. B., Hamlett, C., Binkley, E., & Crouch, R. (2000). Using objective data sources to enhance teacher judgments about test accommodations. *Exceptional Children*, *67*(1), 67-81.

Fuchs, L. S., Fuchs, D., Prentice, K., Hamlett, C. L., Finelli, R., & Courey, S. J. (2004). Enhancing mathematical problem solving among third-grade students with schema-based instruction. *Journal of Educational Psychology, 96*(4), 635–647.

Fuchs, L. S., Fuchs, D., Stuebing, K., Fletcher, J. M., Hamlett, C. L., & Lambert, W. (2008). Problem solving and computational skill: Are they shared or distinct aspects of mathematical cognition? *Journal of Educational Psychology*, *100*, 30–47. https://doi.org/10.1037/0022-0663.100.1.30.Gagnon, J. C., & Maccini, P. (2001). Preparing students with disabilities for algebra. *Teaching Exceptional Children*, *34*(1), 8-15.

Geary, D. C. (2004). Mathematics and learning disabilities. *Journal of learning disabilities*, *37*(1), 4-15.

Geary, D. C., Hamson, C. O., & Hoard, M. K. (2000). Numerical and arithmetical cognition: A longitudinal study of process and concept deficits in children with learning disability. *Journal of experimental child psychology*, *77*(3), 236-263.

Georgia Department of Education, 2021. Georgia's K-12 Mathematics Standards: Mathematical Practices. Retrieved at: https://lor2.gadoe.org/gadoe/file/3cd8fd52-2df7-490f-b716-846f0abaaeb5/1/K-12-Mathematical-Practices.pdf

Gersten, R., Baker, S., Pugach, M., Scanlon, D., & Chard, D. (2001). Contemporary research on special education teaching. In V. Richardson (Ed.), *Handbook of research on teaching* (4th ed., pp. 695–722). AERA.

Gersten, R., Chard, D. J., Jayanthi, M., Baker, S. K., Morphy, P., & Flojo, J. (2009). Mathematics instruction for students with learning disabilities: A meta-analysis of instructional components. *Review of Educational Research*, *79*(3), 1202-1242. https://doi.org/10.3102/0034654309334431

Gewertz, C. (2019). What tests does each state require? *Education Week*. https://www.edweek.org/teaching-learning/what-tests-does-each-state-require/2017/02

Harrison, L., McLeod, S., Berthelsen, D., & Walker, S. (2009) Literacy, numeracy, and learning in school-aged children identified as having speech and language impairment in early childhood. *International Journal of Speech-Language Pathology*, *11*(5), 392–403.

Hasselbring, T. S., & Glaser, C. H. W. (2000). Use of computer technology to help students with special needs. *The Future of Children*, *10*(2), 102-122.

Helwig, R., & Tindal, G. (2003). An experimental analysis of accommodation decisions on large-scale mathematics Tests. *Exceptional Children*, *69*(2), 211-225. https://doi.org/10.1177/001440290306900206

Jitendra, A. K., Griffin, C. C., McGoey, K., Gardill, M. C., Bhat, P., & Riley, T. (1998). Effects of mathematical word problem solving by students at risk or with mild disabilities. *The Journal of Educational Research*, *91*(6), 345-355.

Jochim, A., & McGuinn, P. (2016). The politics of the Common Core assessments: Why states are quitting the PARCC and Smarter Balanced testing consortia. *Education Next*, *16*(4), 44-52.

Judge, S., & Watson, S. M. (2011). Longitudinal outcomes for mathematics achievement for students with learning disabilities. *The Journal of Educational Research*, *104*(3), 147-157.

Kamei-Hannan, C. (2008). Examining the accessibility of a computerized adapted test using assistive technology. *Journal of Visual Impairment & Blindness*, *102*(5), 261–271.

Katsiyannis, A., Zhang, D., Ryan, J. B., & Jones, J. (2007). High-stakes testing and students with disabilities: Challenges and promises. *Journal of Disability Policy Studies*, *18*(3), 160-167.

Kearns, J. F., Towles-Reeves, E., Kleinert, H. L., Kleinert, J. O. R., & Thomas, M. K. K. (2011). Characteristics of and implications for students participating in alternate assessments based on alternate academic achievement standards. *The Journal of Special Education*, *45*(1), 3-14.

King-Sears, M. E., Stefanidis, A., Berkeley, S., & Strogilos, V. (2021). Does co-teaching improve academic achievement for students with disabilities? A meta-analysis. *Educational Research Review*, *34*, 100405.

Klang, N., Karlsson, N., Kilborn, W., Eriksson, P., & Karlberg, M. (2021). Mathematical problem-solving through cooperative learning—the importance of peer acceptance and friendships. *Frontiers in Education*, 6, 710296.

Lein, A. E., Jitendra, A. K., & Harwell, M. R. (2020). Effectiveness of mathematical word problem solving interventions for students with learning disabilities and/or mathematics difficulties: A meta-analysis. *Journal of Educational Psychology*, *112*(7), 1388

Lucangeli, D., & Cabrele, S. (2006). Mathematical difficulties and ADHD. *Exceptionality*, *14*(1), 53-62.

Marston, D., Muyskens, P., Lau, M., & Canter, A. (2003). Problem-solving model for decision making with high-incidence disabilities: The Minneapolis experience. *Learning Disabilities Research & Practice*, *18*(3), 187-200.

Martínez, R. S. (2011). Disability and the use of ICT in education: Do students with special needs recognize the support given by teachers when using technology. *Problems of Education in the 21st Century*, *35,* 149-158.

Mayes, S. D., Calhoun, S. L., & Crowell, E. W. (2000). Learning disabilities and ADHD: Overlapping spectrum disorders. *Journal of learning disabilities*, *33*(5), 417-424.

Miller, S. P., & Mercer, C. D. (1997). Educational aspects of mathematics disabilities. *Journal of learning disabilities*, *30*(1), 47-56.

Montague, M. (2008). Self-regulation strategies to improve mathematical problem solving for students with learning disabilities. *Learning Disability Quarterly*, *31*(1), 37-44.

Murphy, A. F., & Haller, E. (2015). Teachers' perceptions of the implementation of the literacy common core state standards for English language learners and students with disabilities. *Journal of Research in Childhood Education*, *29*(4), 510-527.

Murphy, M. R., & Marshall, K. J. (2015). Common core preparation in special education teacher education programs: Beginning the conversation. *Teacher Education and Special Education*, *38*(3), 167-185.

No Child Left Behind (NCLB) Act of 2001, Pub. L. No. 107-110, § 101, Stat. 1425 (2002).

National Center for Education Statistics. (n.d.). *Digest of education statistics*. https://nces.ed.gov/programs/digest/d20/tables/dt20_204.30.asp

National Center for Education Statistics (2005). *The Nation's Report Card: Mathematics 2009* (NCES 2010–451). National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education, Washington, D.C.

National Center for Education Statistics (2009). *The Nation's Report Card: Mathematics 2009* (NCES 2010–451). National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education, Washington, D.C.

Parmar, R. S., Cawley, J. F., & Frazita, R. R. (1996). Word problem solving by students with and without mild disabilities. *Exceptional children*, *62*(5), 415-429.

Porter, A., McMaken, J., Hwang, J., & Yang, R. (2011). Common Core standards: The new U.S. intended curriculum. *Educational Researcher*, *40*(3), 103–116.

Powell, S. R., Fuchs, L. S., & Fuchs, D. (2013). Reaching the mountaintop: Addressing the common core standards in mathematics for students with mathematics difficulties. *Learning Disabilities Research & Practice*, *28*(1), 38-48.

Saunders, A. F., Bethune, K. S., Spooner, F., & Browder, D. (2013). Solving the common core equation: Teaching mathematics CCSS to students with moderate and severe disabilities. *Teaching Exceptional Children*, *45*(3), 24-33.

Schulte, A. C., & Stevens, J. J. (2015). Once, sometimes, or always in special education: Mathematics growth and achievement gaps. *Exceptional Children*, *81*(3), 370-387.

Shalev, R. S., Manor, O., Kerem, B., Ayali, M., Badichi, N., Friedlander, Y., & Gross-Tsur, V. (2001). Developmental dyscalculia is a familial learning disability. *Journal of learning disabilities*, *34*(1), 59-65.

Smarter Balanced (2022). *Usability, accessibility, and accommodations guidelines*. https://portal.smarterbalanced.org/library/en/usability-accessibility-and-accommodations-guidelines.pdf

Stephan, M., & Smith, J. (2012). Teaching Common Core Math Practices to Students with Disabilities. *Journal of the American Academy of Special Education Professionals*, *162*-175.

Spooner, F., Saunders, A., Root, J., & Brosh, C. (2017). Promoting access to common core mathematics for students with severe disabilities through mathematical problem solving. *Research and Practice for Persons with Severe Disabilities*, *42*(3), 171-186.

Stevens, J. J., Schulte, A. C., Elliott, S. N., Nese, J. F., & Tindal, G. (2015). Growth and gaps in mathematics achievement of students with and without disabilities on a statewide achievement test. *Journal of School Psychology*, *53*(1), 45-62.

Stichter, J. P., Conroy, M. A., & Kauffman, J. M. (2008). *An introduction to students with high-incidence disabilities*. Prentice Hall.

Swanson, H. L., & Hoskyn, M. (1998). Experimental intervention research on students with learning disabilities: A meta-analysis of treatment outcomes. *Review of educational research*, *68*(3), 277-321.

Tennessee State Board of Education. (n.d.). *Standards Review: Math*. https://www.tn.gov/sbe/committees-and-initiatives/standards-review/math.htmlTennessee Department of Education, 2021. Academic Standards Mathematics: Mathematics: Standards for Mathematical Practice. Retrieved at: https://www.tn.gov/content/dam/tn/education/standards/math/std_math_standards_mathematical_practice.pdf

Thurlow, M., Lazarus, S. S., Albus, D., & Hodgson, J. (2010). *Computer-based testing: Practices and considerations* (Synthesis Report 78). *University of Minnesota, National Center on Educational Outcomes.*

Tyson, P. A. (2015). The digital divide and inequities for students with disabilities: A bridge over troubled waters! *Journal of the American Academy of Special Education Professionals*, *151*- 162.

U.S. Department of Education. (2015). *School practices and accountability for students with disabilities.* https://ies.ed.gov/ncee/pubs/20154006/pdf/20154006.pdf

Van Garderen, D. (2007). Teaching students with LD to use diagrams to solve mathematical word problems. *Journal of learning disabilities*, *40*(6), 540-553.

Wagner, M., Newman, L., Cameto, R., & Levine, P. (2006). *The academic achievement and functional performance of youth with disabilities: A report of findings from the National Longitudinal Transition Study–2(NLTS2)*. SRI International.

Wei, X. (2024). Text-to-speech technology and math performance: A comparative study of students with disabilities, English Language Learners, and their general education peers. *Educational Researcher*, 0013189X241232995.

Wei, X., Lenz, K. B., & Blackorby, J. (2013). Math growth trajectories of students with disabilities: Disability category, gender, racial, and socioeconomic status differences from ages 7 to 17. *Remedial and Special Education*, *34*(3), 154-165.

Wei, X., & Zhang, S. (2024). Extended time accommodation and the academic, behavioral, and psychological outcomes of students with learning disabilities. *Journal of Learning Disabilities*, *57*(4), 242-254.

Witzel, B. S., Mercer, C. D., & Miller, M. D. (2003). Teaching algebra to students with learning difficulties: An investigation of an explicit instruction model. *Learning Disabilities Research & Practice*, *18*(2), 121-131.

Xin, Y. P., & Jitendra, A. K. (1999). The effects of instruction in solving mathematical word problems for students with learning problems: A meta-analysis. *The Journal of Special Education*, *32*(4), 207-225.

Xin, Y. P., Jitendra, A. K., & Deatline-Buchman, A. (2005). Effects of mathematical word Problem—Solving instruction on middle school students with learning problems. *The Journal of Special Education*, *39*(3), 181-192.

Zentall, S. S. (2007). Math performance of students with ADHD: Cognitive and behavioral contributors and interventions. In D. B. Berch & M. M. M. Mazzocco (Eds.), *Why is math so hard for some children? The nature and origins of mathematical learning difficulties and disabilities* (pp. 219–243). Paul H. Brookes Publishing Co.

Zentall, S. S., & Ferkis, M. A. (1993). Mathematical problem solving for youth with ADHD, with and without learning disabilities. *Learning Disability Quarterly*, *16*(1), 6-18.

Table 1. Summary Statistics of Demographic Characteristics for Students in Our Analytic Sample and for Students in the State of California

	2009 – 2019 All years		2008-09 Subsample		2018-19 Subsample		2018-19 California Statewide
	Mean	SD	Mean	SD	Mean	SD	Mean
Female	0.49	(0.50)	0.50	(0.50)	0.49	(0.50)	0.49
FRPM	0.59	(0.49)	0.53	(0.50)	0.59	(0.49)	0.59
English Learner	0.19	(0.39)	0.21	(0.41)	0.17	(0.37)	0.19
Classified as having a disability (SWD)	0.11	(0.31)	0.08	(0.27)	0.13	(0.34)	0.13
Low incidence disabilities	0.01	(0.09)	0.01	(0.08)	0.01	(0.09)	0.02
High incidence disabilities	0.10	(0.30)	0.07	(0.26)	0.12	(0.33)	0.11
Specific learning disability (SLD)	0.06	(0.24)	0.04	(0.20)	0.07	(0.25)	0.05
Autism (AUT)	0.01	(0.08)	0.00	(0.05)	0.01	(0.09)	0.02
Speech or language impairment (SLI)	0.02	(0.15)	0.02	(0.15)	0.02	(0.15)	0.02
Other health impairment (OHI)	0.01	(0.11)	0.01	(0.07)	0.02	(0.14)	0.03
Parent Education:							
College	0.24	(0.43)	0.21	(0.41)	0.28	(0.45)	-
Some college	0.27	(0.44)	0.26	(0.44)	0.27	(0.44)	-

High school	0.24	(0.43)	0.24	(0.42)	0.24	(0.43)	-
No high school	0.19	(0.39)	0.20	(0.40)	0.16	(0.37)	-
Not provided	0.06	(0.24)	0.09	(0.28)	0.06	(0.23)	-
Language at home:							
English	0.60	(0.49)	0.60	(0.49)	0.61	(0.49)	0.80
Spanish	0.36	(0.48)	0.37	(0.48)	0.35	(0.48)	0.16
Other languages	0.04	(0.19)	0.03	(0.18)	0.04	(0.20)	0.04
Birthplace: US	0.94	(0.24)	0.91	(0.29)	0.96	(0.21)	-
Birthplace: non-US	0.06	(0.24)	0.09	(0.29)	0.04	(0.21)	-
Race/Ethnicity:							
Asian	0.05	(0.22)	0.05	(0.22)	0.05	(0.22)	0.12
Hispanic	0.60	(0.49)	0.58	(0.49)	0.62	(0.48)	0.55
Black	0.06	(0.23)	0.06	(0.24)	0.05	(0.23)	0.05
White	0.22	(0.42)	0.26	(0.44)	0.19	(0.40)	0.23
Other races	0.07	(0.25)	0.05	(0.23)	0.07	(0.26)	0.05
Charter School	0.02	(0.16)	0.02	(0.14)	0.03	(0.16)	0.11
Magnet School	0.04	(0.19)	0.04	(0.19)	0.04	(0.19)	-
Observations	1,408,400		152,511		155,752		6,186,278

Source: Administrative data from the Riverside County of Education (2009 - 2019) for students in tested grades in 17 districts. California state-level data from ED-Data.org/state/CA (2018-19).

Table 2. Percentages of SWDs Included in Different Forms of Standardized Testing in Math over time

	STAR			CAASPP	
Year	CST	CMA	CAPA	SBAC	CAA
2009	95.25%	3.84%	0.90%		
2010	94.51%	4.57%	0.92%		
2011	94.09%	4.97%	0.93%		
2012	93.98%	5.07%	0.93%		
2015				100.00%*	0.00%
2016				99.48%	0.52%
2017				98.91%	1.09%
2018				98.90%	1.10%
2019				98.88%	1.12%

Source: Administrative data from the Riverside County of Education 2009 – 2019. *There was no operational CAA testing in 2015

Table 3. Summary Statistics of Student Achievement

	N	Mean	SD	Min	Max
CST/CMA Math Scale Score (2009 – 2012)	620,974	357.48	78.96	150	600
CST/CMA Math Standardized Score (2009 – 2012)	620,974	-0.00	1.00	-3.22	5.70
SBAC Math Scale Score (2015 – 2019)	787,426	2489.93	107.53	2189	2862
SBAC Math Standardized Score (2015 – 2019)	787,426	0.00	1.00	-3.26	2.91

Source: Administrative data from the Riverside County of Education (2009 - 2019) for students in tested grades in 17 districts.

Table 4. Percentages of Students Identified with Disability Categories over Time

Year	All SWDs	AUT	OHI	SLD	SLI	Low incidence
2009	8.06%	0.25%	0.55%	4.33%	2.32%	0.61%
2010	9.63%	0.36%	0.78%	5.35%	2.40%	0.74%
2011	10.10%	0.43%	0.88%	5.51%	2.53%	0.74%
2012	10.27%	0.49%	0.98%	5.69%	2.38%	0.73%
2015	11.37%	0.65%	1.42%	6.31%	2.21%	0.78%
2016	11.91%	0.69%	1.62%	6.56%	2.23%	0.81%
2017	12.21%	0.74%	1.75%	6.73%	2.19%	0.80%
2018	12.72%	0.84%	1.98%	6.82%	2.22%	0.86%
2019	13.17%	0.91%	2.05%	6.97%	2.40%	0.84%

Source: Administrative data from 17 districts in Riverside County 2009 – 2019.

Table 5. Percentages of Students in each Disability Category Included in Testing over Time

Year	Without disability	All SWD	AUT	OHI	SLD	SLI	Low incidence
2009	96.74%	78.39%	78.32%	76.07%	73.20%	92.46%	74.80%
2010	97.30%	90.96%	91.35%	89.98%	88.53%	98.42%	87.58%
2011	97.44%	93.85%	94.81%	94.15%	92.08%	98.75%	90.58%
2012	97.81%	95.08%	95.95%	94.32%	94.18%	98.91%	90.78%
2015	98.31%	93.96%	83.45%	93.85%	97.05%	98.11%	73.94%
2016	97.59%	95.01%	91.03%	94.55%	96.32%	98.00%	82.81%
2017	98.64%	96.42%	92.73%	94.63%	97.51%	98.42%	90.04%
2018	98.76%	96.73%	94.63%	95.70%	97.34%	98.73%	91.63%
2019	98.66%	96.59%	94.41%	94.63%	97.53%	98.58%	90.90%

Source: Administrative data from 17 districts in Riverside County 2009 – 2019.

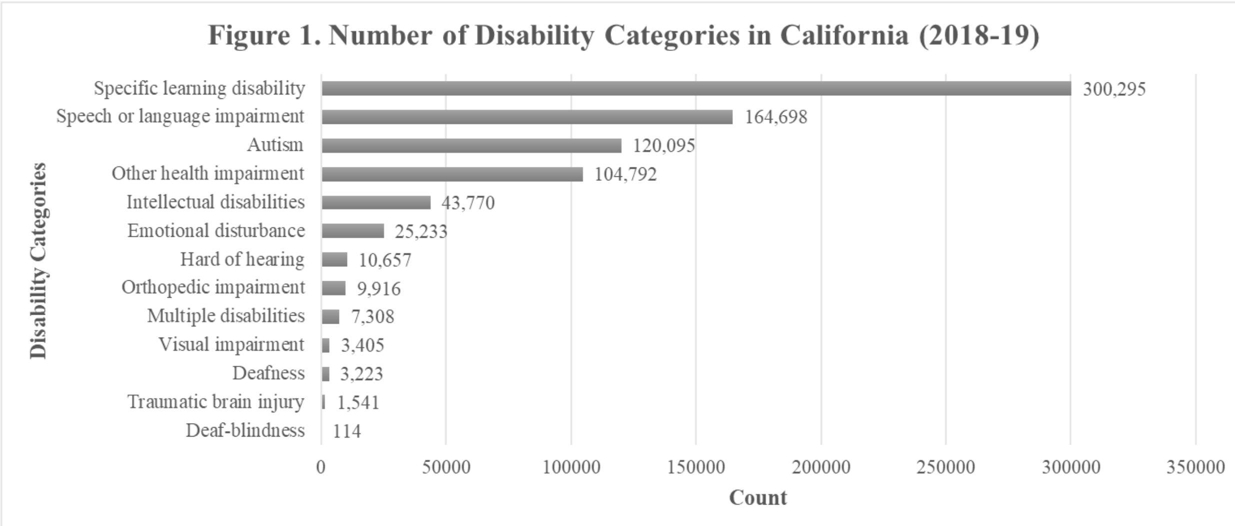

Figure 1. Special education enrollment by disability 2018-19 academic year
Source: The Digest of Education Statistics - https://www.cde.ca.gov/sp/se/sr/cefspeced.asp

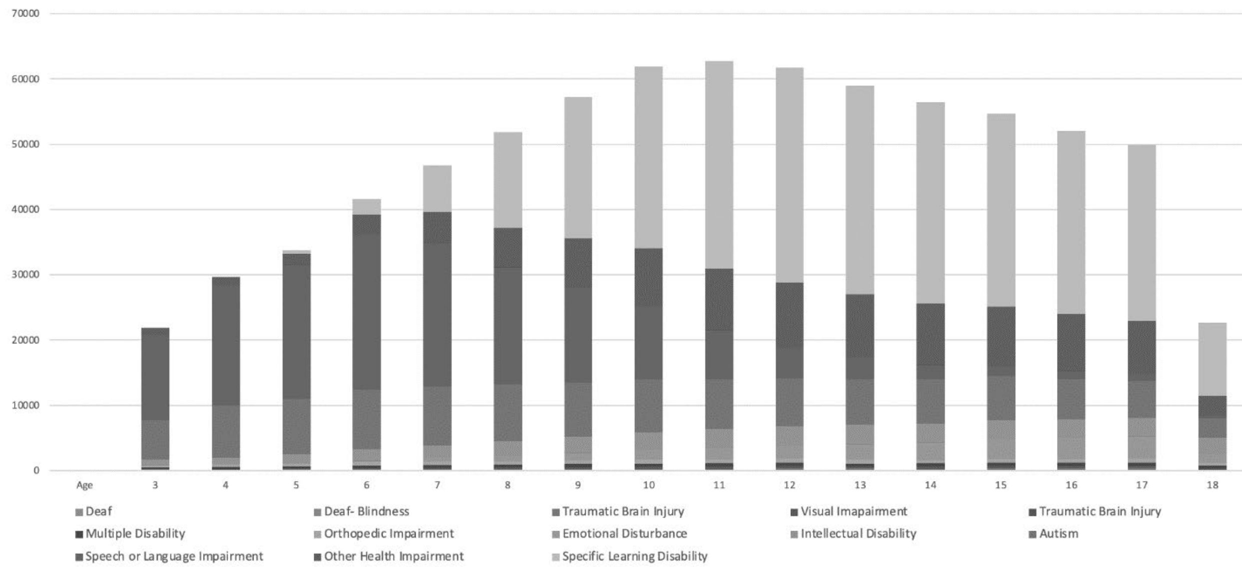

Figure 2. Distribution of disabilities of California students by age, 2018-19 academic year
Source: California Department of Education
https://data1.cde.ca.gov/dataquest/SpecEd/SpecEd1.asp?cChoice=SpecEd1&cYear=2018-19&cLevel=State&cTopic=SpecEd&myTimeFrame=S&submit1=Submit&ReptCycle=December

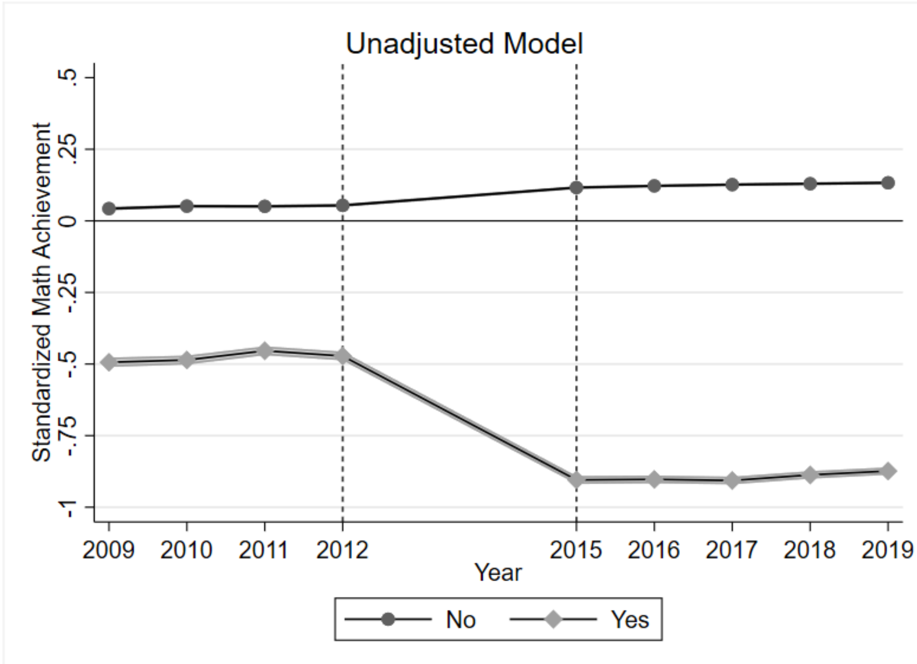

Figure 3. Predicted math achievement by disability and year, unadjusted model
Source: Administrative data from the Riverside County of Education 2009 – 2019. Each point is surrounded by 95% confidence interval.

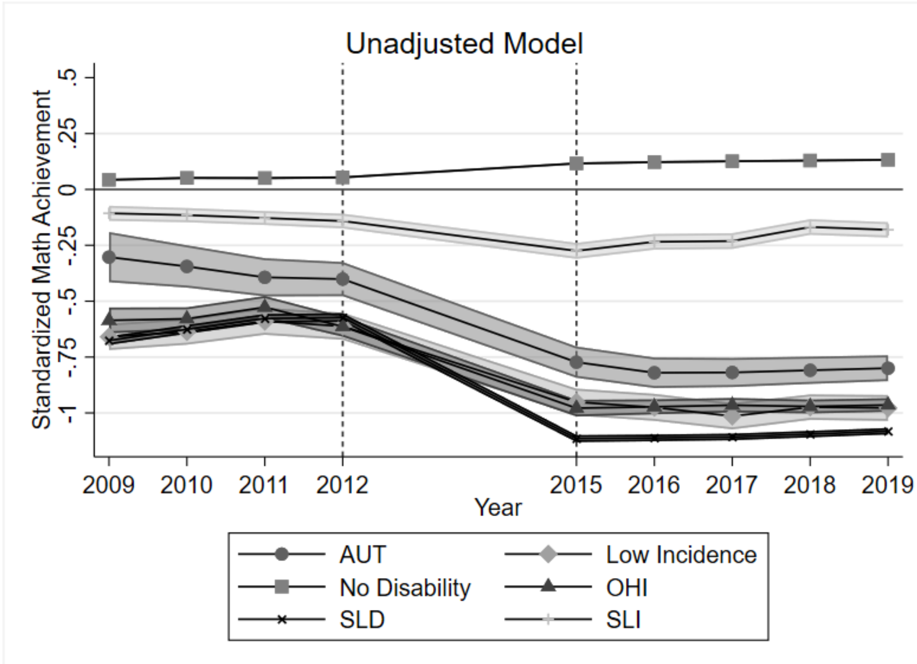

Figure 4. Predicted math achievement by disability category and year, unadjusted model
Source: Administrative data from the Riverside County of Education 2009 – 2019. Each point is surrounded by 95% confidence interval.

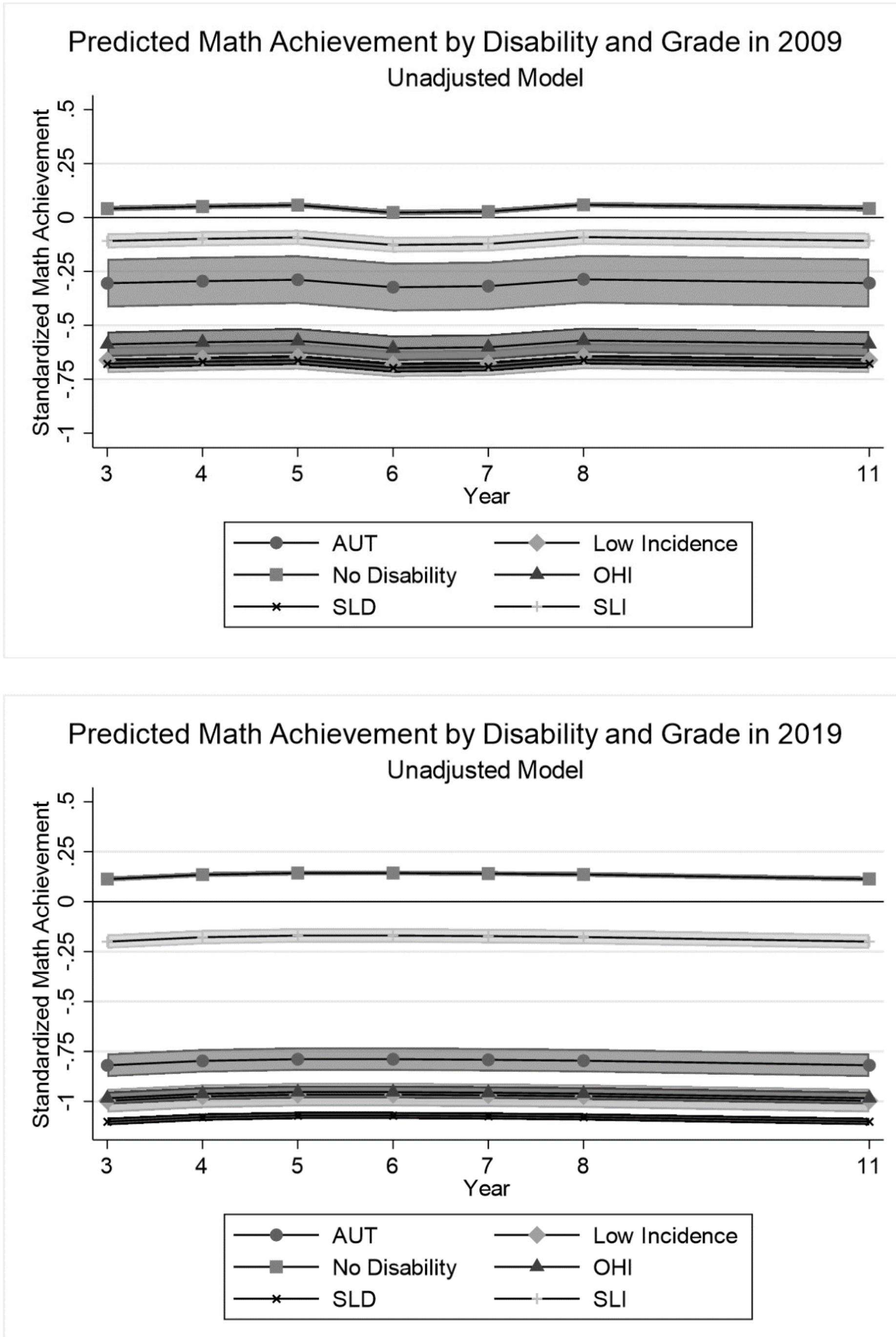

Figure 5. Predicted math achievement by disability category and grade in school years ending in 2009 and 2019, using the unadjusted model

Source: Administrative data from the Riverside County of Education 2009 – 2019. Each point is surrounded by 95% confidence interval.

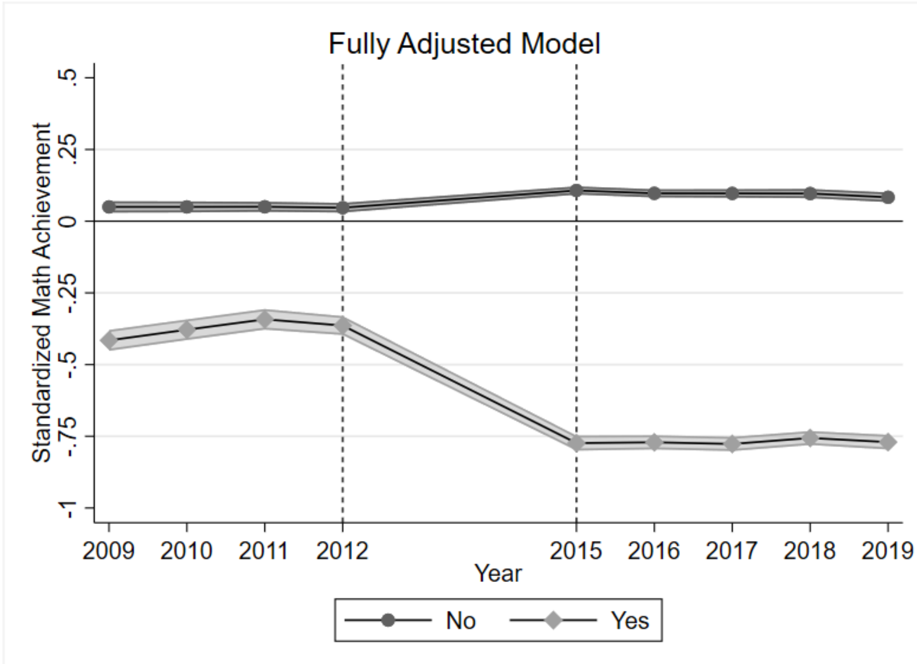

Figure 6. Predicted math achievement by disability and year, using the adjusted model
Source: Administrative data from the Riverside County of Education 2009 – 2019. Each point is surrounded by 95% confidence interval.

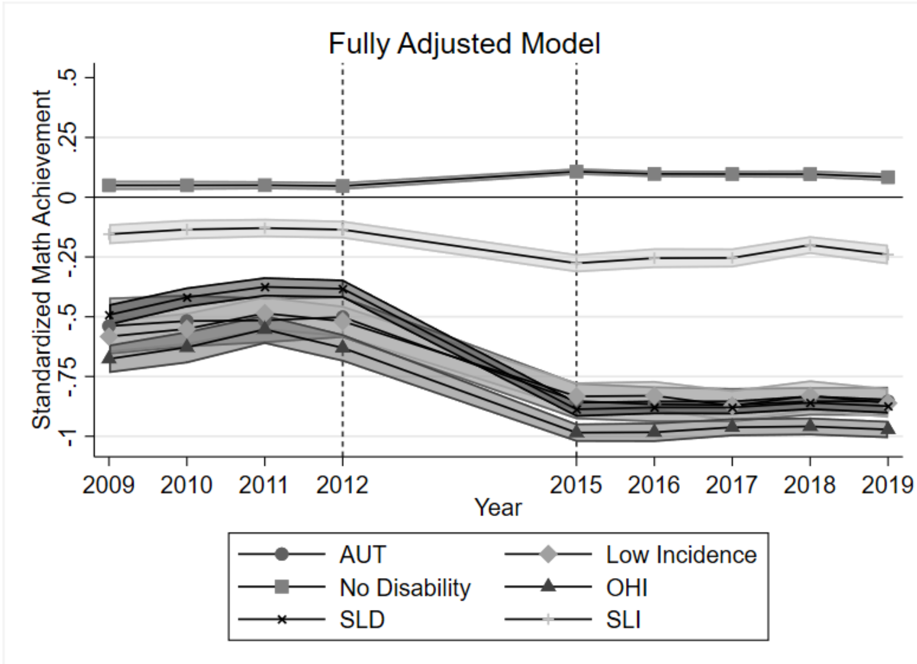

Figure 7. Predicted math achievement by disability category and year, adjusted model
Source: Administrative data from the Riverside County of Education 2009 – 2019. Each point is surrounded by 95% confidence interval.

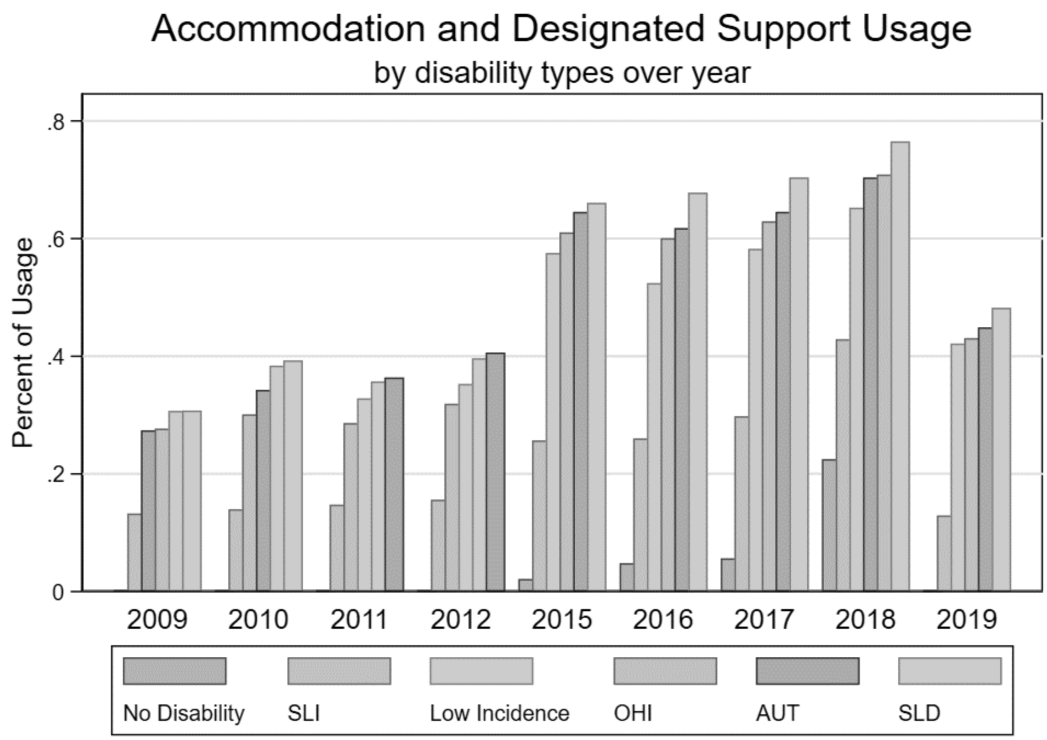

Figure 8. Accommodation and designated support usage, by disability category and year
Source: Administrative data from the Riverside County of Education 2009 – 2019.

[1] In 2010, 12 states joined *both* the SBAC and PARCC, with 31 states joining SBAC and 26 states signing up for PARCC (Coalition to Protect Our Public Schools (n.d.)). In 2015, 16 states remained participating in the SBAC consortia, and 6 states continued to participate in the PARCC consortia (Jochim & McGuinn, 2016). In 2019, 15 states and Washington D.C. utilized either PARCC or SBAC for their assessments (Gewertz, 2019). Currently, only Massachusetts, Louisiana, the District of Columbia, the Federal Bureau of Indian Education, and the Department of Defense Educational Activity use PARCC.

[2] The most recent published data are from 2018-19. It shows that a total of 795,047 students in California received special education services. https://www.cde.ca.gov/sp/se/sr/cefspeced.asp

[3] The definitions associated with each disability code can be found at: https://www.cde.ca.gov/ta/tg/ca/disablecodes.asp

[4] See the Digest of Education Statistics - https://nces.ed.gov/programs/digest/d20/tables/dt20_204.30.asp

[5] Other Health Impairment means having limited strength, vitality or alertness, due to chronic or acute health problems such as a heart condition, tuberculosis, rheumatic fever, nephritis, asthma, sickle cell anemia, hemophilia, epilepsy, lead poisoning, leukemia, or diabetes, which adversely affects a child's educational performance. (34 CFR Part 300.8 (c) (9)) (https://www.cde.ca.gov/ta/tg/ca/disablecodes.asp).

[6] However, ADHD can also be designated for special needs under SLD and ED (https://casponline.org/about-casp/individualized-education-program-timelines-and-eligibility-faq/ accessed 7/26/22).

[7]NCLB originally required all students to perform at 100% proficiency by 2014, threatening Title I funding if goals were not met. However, as this unrealistic goal was not reached, Secretary of Education Arne Duncan under the Obama administration granted waivers to states and districts in exchange for improvement plans deemed acceptable.

[8] A small number of SWDs were permitted to take a paper and pencil test, but this accommodation was very rare.

[9] Riverside County contains a total of 23 districts, but we restrict our sample to 17 districts because six districts did not fully report test scores to the county in the period of the STAR exam.

[10] These are students in our data with disability diagnoses. The vast majority (more than 95%) of these students have an Individualized Education Plan (IEP). An IEP, a key component of the Individuals with Disabilities Education Act (IDEA), is a plan developed for each student who receives special education services. A small number of students have a 504 plan, which is typically for students with disabilities who do not receive special education services but still need accommodations to access the same curriculum as their non-disabled peers.

[11] SBAC stands for “Smarter Balanced Assessment Consortium”—the original term for the assessment.

[12] Data prior to 2008-09 were poor in quality.

[13] All tests underwent procedures to gather evidence of their psychometric properties, ensuring the validity and reliability of these tests (California Department of Education, n.d.)

[14] We say we ran the “equivalent” of cross-sectional regressions because, to facilitate the visual representation of our results with plots, we ran our specifications on pooled data for all years and interacted the year variable with all right-hand-side variables, which produces point estimates that are identical to those obtained from separate year-by-year regressions.

[15] We use the Stata margins command after running the ordinary least squares models to predict math scores (adjusted prediction), which allows us to account for student characteristics and school-fixed effects. Adjusted predictions are useful in interpreting the differential effects of a disability category on the math score (i.e., the values of all other covariates are fixed, except for the disability categories).

[16] We also used a more flexible model that interacted all characteristics contained in the x vector with each SWD dummy, but it did not result in substantially different results, so we present only the results from equation (2) as our “fully” adjusted model.

[17] These percentages of test-takers include the roughly one percent of students who took the CAPA in the STAR years and the CAA in the CAASPP years.

[18] According to sources at the Riverside County Office of Education, the lower percentage of SWD test-takers in 2009 was due to the due to the lack of an alternative exam in certain grades and greater opt out by parents because they did not have an alternative exam.