



December 2017

Paraeducators: *Statewide Variation and Association with Academic Outcomes*

The 2017 Washington State Legislature directed the Washington State Institute for Public Policy (WSIPP) to “examine variation in the use of paraeducators across public schools and school districts and analyze whether and the extent that any differences in students’ academic progress can be attributed to the use of paraeducators. The study must also include a review of the national research literature on the effectiveness of paraeducators in improving student outcomes.”¹

This report is organized as follows:

Section I provides background information on paraeducators in Washington and defines terms used in this report.

Section II defines our research questions and describes the methods used to answer these questions.

Section III describes our findings on the variation of paraeducators across districts and public schools in Washington State.

Section IV describes findings from our statewide analysis of paraeducators and student outcomes.

Section V describes the methods and findings from our national research literature review.

Section VI provides a summary of our analyses and notes limitations.

Summary

The Washington State Legislature directed WSIPP to examine variation in the use of paraeducators across Washington, how paraeducators impact students’ academic outcomes, and what the national research says about the effectiveness of paraeducators in improving student outcomes.

We focused our analyses on paraeducators in Washington who perform teaching activities, whom we refer to as instructional aides. Using Washington State data, we used a fixed effects regression model to examine which factors, if any, are associated with the use of instructional aides and whether instructional aides are associated with school-level student outcomes. Below is a summary of our findings.

- Districts with more total students or a higher proportion of students in special education had more instructional aide FTEs. Districts with larger class sizes had fewer FTEs.
- Schools with more teachers, more educational staff, a higher proportion of students in special education and eligible for free or reduced-price meals, and Title I-funded schools had more instructional aide FTEs. Schools with more students in English proficiency programs and more administrative staff had fewer FTEs.
- An additional instructional aide FTE is associated with a small increase in the proportion of students meeting state standards on math, reading, writing and English language arts in some grades.
- We found no association between instructional aide FTEs and graduation rates.

Finally, in our literature review, we found that—on average—paraeducators have a small effect or no effect on students’ academic outcomes.

¹ Engrossed Substitute House Bill 1115, Chapter 237, Laws of 2017.

I. Background

Broadly speaking, paraeducators are school employees who provide instruction or other services to students and their families under the supervision of licensed teachers or other professional practitioners.² As such, paraeducators may be responsible for a broad variety of duties. For example, paraeducators may tutor students one-on-one or in small groups, assist teachers by taking attendance and recording grades, or work with school counselors to support students at risk of dropping out of school or failing classes.

Two main definitions (and associated credentialing standards) apply to paraeducators working in Washington State. Under the federal Title I, Part A funding program—which provides financial assistance to schools and school districts with high numbers of children from low-income families—paraeducators are referred to as paraprofessionals.³ In this context, paraeducators are local education authority (LEA) employees who work in Title I, Part A-funded schools or programs and provide instructional support. This includes activities like assisting with classroom management and acting as a translator and excludes activities like working in food services or playground supervision.⁴

In Washington, paraeducators are defined in statute as non-certificated school staff working under the supervision of classroom teachers and other licensed staff to provide

instructional and other support to students and families.⁵

Across the country, as well as in Washington, paraeducators perform the following types of duties:

- clerical (e.g., taking attendance or recording grades),
- instructional (e.g., tutoring students one-on-one or in groups),
- monitoring/student management (e.g., supervising a class while a teacher is away), and
- guidance and support (e.g., teaching students study skills or connecting them with school and community resources).

Washington State has minimum qualification requirements for paraeducators. Paraeducators working in regular education classrooms must hold a high school diploma or GED.⁶ Paraeducators working in special education classrooms are required to meet specific knowledge and skills competencies.⁷

Paraeducators working in Title I, Part A-funded schools or targeted programs must meet additional qualification standards. The federal Every Student Succeeds Act (enacted in December 2015), modified these credentialing requirements—requiring

² Pickett, A. (1999) Paraeducators: factors that influence their performance, development, and supervision.

³ U.S. Department of Education. Title I, Part A.

⁴ U.S. Department of Education. Title I, Part A. Section 1119 (g).

⁵ Revised Code of Washington 28A.413.010.

⁶ Office of Superintendent of Public Instruction website. Paraeducators.

⁷ Washington Administrative Code 392-172A-02090. Note that several federal and state funding streams which support special education and limited English proficiency programs may be used to fund paraeducators working with students in these programs.

states to establish their own minimum qualification standards.⁸

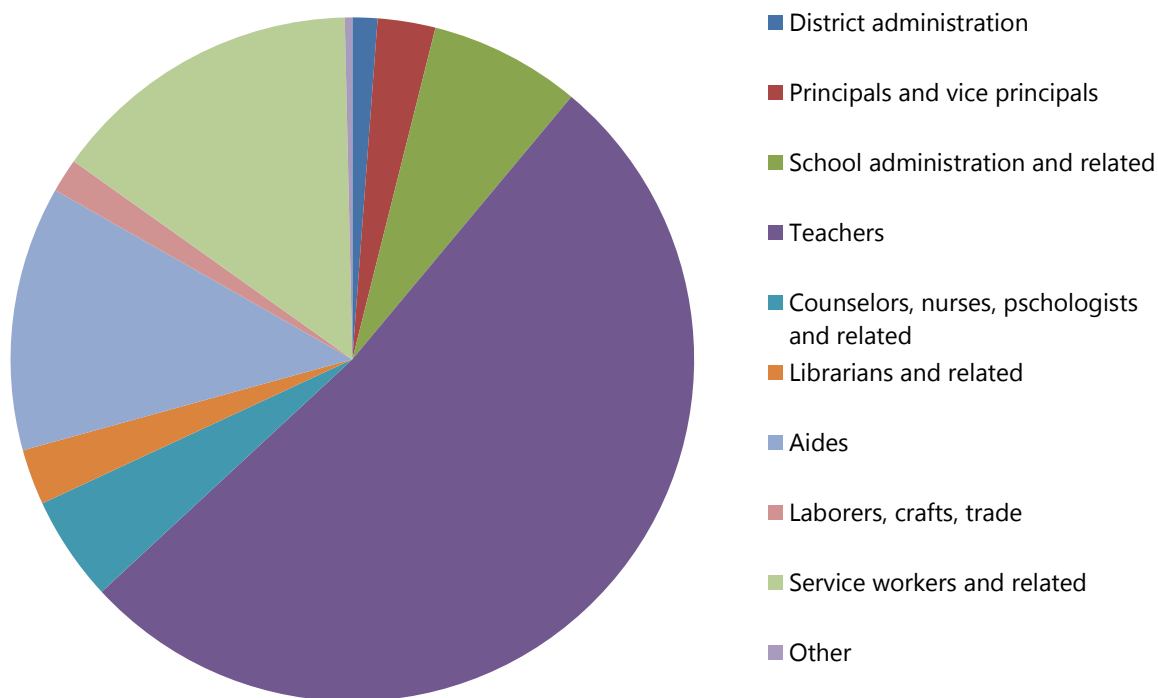
Statewide trends

The Office of Superintendent of Public Instruction (OSPI) personnel data tracks paraeducators and staff conducting similar activities under the staffing category of “aides.”⁹ Aides make up the third largest category of personnel in elementary and secondary schools (Exhibit 1).

The number of full-time equivalent (FTE) aide staff has steadily increased over time. Overall, aide FTEs increased 12% from the 2009-10 school year to the 2015-16 school year.¹⁰ Comparatively, statewide student enrollment increased 5% over the same period.¹¹

Exhibit 1

All School and District Staffing Duties



⁸ OSPI is currently transitioning from No Child Left Behind (NCLB) to Every Student Succeeds Act (ESSA) federal standards and requires paraeducators in Title I, Part A-funded schools and programs to meet NCLB standards until ESSA is fully implemented. No authors. Title I, Part A guide to paraeducator requirements. Office of Superintendent of Public Instruction.

⁹ OSPI: Aides “assist classroom teachers or staff members performing professional educational teaching assignments on a regularly scheduled basis, [including] teacher aides, classroom attendants, bus monitors, lunchroom aides, community service aides, etc.”

¹⁰ Statewide personnel assignment summary profiles. Table 7: All school personnel by duty for school years 2009-10 and 2015-16.

¹¹ OSPI data and reports.

Exhibit 2

Aides by School Year

	2009-10	2015-16
FTE	12,278	13,893
Individuals	23,561	26,035

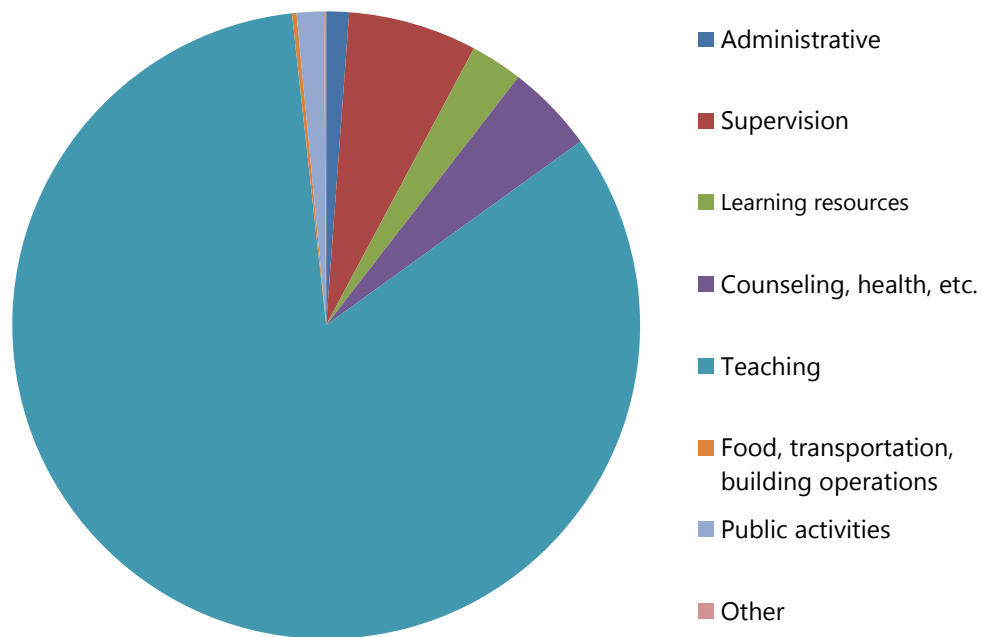
Instructional Aides

Instructional aides, as we refer to them in this report, are a subset of aides who are assigned specifically to work in teaching activities in schools. These types of instructional support activities are the subset of activities that would most likely involve a paraeducator working directly with students on academic issues.

The majority of aides in Washington provide instructional support to teachers and students ([Exhibit 3](#)). Instructional aides accounted for roughly 85% of total aide FTEs in each school year from 2009-10 to 2015-16.¹² For comparison, student supervision is the second most common activity aides are assigned to, accounting for almost 7% of all aide FTEs.¹³

Exhibit 3

Activities Performed by Aides in Districts and Schools



¹² OSPI Statewide personnel assignment summary profiles. Table 13: All school personnel by duty and activity for school years 2009-10 and 2015-16.

¹³ Aides working in “pupil management and safety” is the second largest category of defined activity, comprising 6% of total aide FTEs from 2009-10 to 2015-16.

Instructional aide FTEs increased at roughly the same rate as overall aide FTEs: 13% from school year 2009-10 to 2015-16.¹⁴ (Exhibit 4)

Exhibit 4

Instructional Aides by School Year

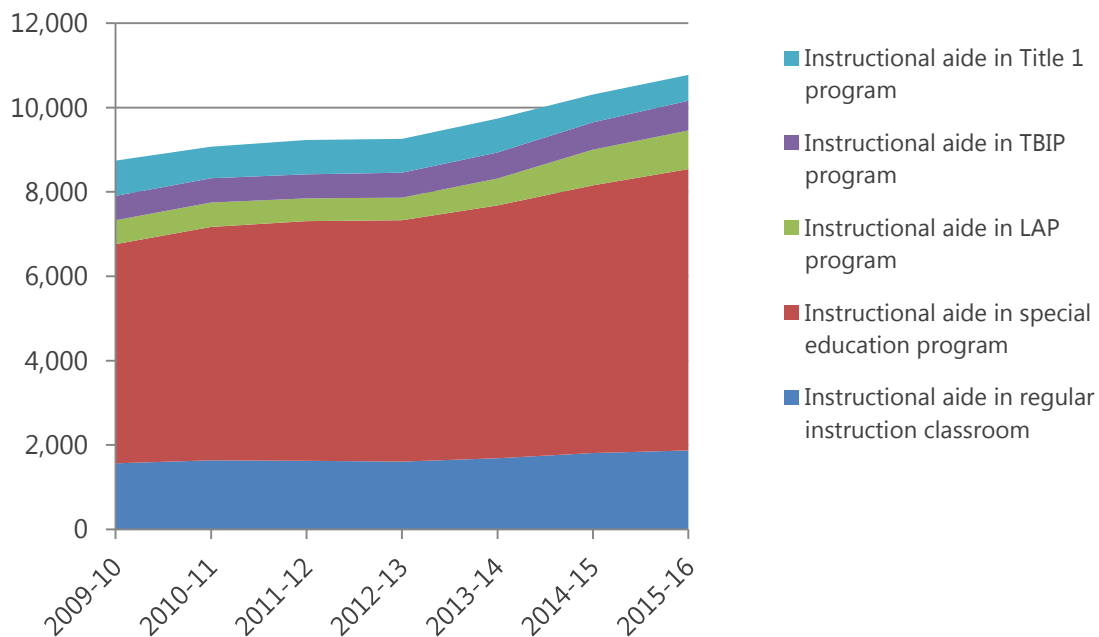
	2009-10	2015-16
FTE	10,238	11,561
Individuals	20,296	22,484

In school years 2009-10 to 2015-16, over half of all instructional aide FTEs were employed in special education instruction programs. Instructional aide employment in special education programs also steadily increased over time, compared to instructional aide FTEs in regular classrooms, which has remained constant over time (Exhibit 5).

The second largest category of instructional aide FTEs work in regular education classrooms. Approximately 20% of instructional aide FTEs work in the Learning Assistance Program, the Transitional Bilingual Instruction Program (TBIP),¹⁵ and Title I programs combined¹⁶ (Exhibit 5).

Exhibit 5

Instructional Aide FTEs by Program



¹⁴ OSPI statewide personnel assignment summary profiles. Table 13 all school personnel by duty and activity for school years 2009-10 and 2015-16.

¹⁵ The TPIB provides language proficiency instruction to English language learners. OSPI migrant and bilingual education website.

¹⁶ Instructional aide FTEs are also designated in other compensatory education programs, vocational education programs, and skills center programs. No author. (2016) Accounting manual for public school districts in the state of Washington.

Legislative History

Recently, the Washington legislature passed several bills focused specifically on paraeducators. In 2014, the legislature passed Substitute Senate Bill 6129, which required the Professional Educator Standards Board to create a paraeducator work group. This work group was tasked with providing the legislature with recommendations for minimum employment standards, certificate programs, teacher trainings, and professional development opportunities for paraeducators.¹⁷

In 2017, the legislature passed Engrossed Substitute House Bill 1115, which created a paraeducator board to implement recommendations set forth by the paraeducator work group.¹⁸ ESHB 1115 also assigned WSIPP to study the use of paraeducators and associations with student outcomes as described in this report.

Research Questions

The legislative assignment contains three basic research questions:

- 1) How does the use of paraeducators vary across the state?
- 2) Is the use of paraeducators associated with students' academic outcomes?
- 3) What does the national research literature say about the impact of paraeducators on student outcomes?

¹⁷ Substitute Senate Bill 6129, Chapter 136, Laws of 2014. Washington is currently transitioning to meet Every Student Succeeds Act federal standards, which also outlines standards for paraprofessionals. No author. (2017) Washington's ESSA Consolidated Plan.

¹⁸ No author. (2016) K-12 education paraeducator development. State of Washington Professional Educator Standards Board.

Legislative Assignment

The Washington state institute for public policy shall conduct a study on the effectiveness of paraeducators in improving student outcomes in Washington state. The study must examine variation in the use of paraeducators across public schools and school districts and analyze whether and the extent that any differences in students' academic progress can be attributed to the use of paraeducators. The office of the superintendent of public instruction and the education data center shall provide the data necessary to conduct the analysis. The study must also include a review of the national research literature on the effectiveness of paraeducators in improving student outcomes.

Engrossed Substitute House Bill 1115,
Chapter 237, Laws of 2017.
RCW 28A.413.097.

We describe our methods and associated results for the first two questions in the following section. [Section V](#) describes our methods and results for answering the third question. Additional details are available in the [Technical Appendix](#) of this report.

II. Paraeducators in Washington: Methods

Two questions we examined are specific to Washington State:

- 1) How does the use of paraeducators vary across the state?
- 2) Is the use of paraeducators associated with students' academic outcomes?

In this section we first describe the data we use to address both questions. We then describe our methods to answer each question.

Data and Definitions

We use a variety of school- and district-level aggregate data to conduct our analyses. We use data from school years 2009-10 to 2015-16, unless otherwise noted. Below, we define key terms and describe associated data sources, then briefly describe other data used in our analyses.¹⁹

Aides and Instructional Aides

Annually, districts report school personnel staffing levels to OSPI. This data is categorized by duty (e.g., aide, superintendent, secondary teacher), activity (e.g., teaching, food operations), and the program in which individuals work (e.g., basic education, special education). Given that an individual can perform multiple functions within a school, we focus on the full-time equivalent (FTE) staff units that have "aide" duties. To calculate aide FTEs, we assume full-time employment for a complete academic school year—260 eight-hour work days.

¹⁹ Additional detail on the data and definitions used in this report is available in Appendix II.

In our analyses we want to observe, as best as possible, the subset of aides that provide instructional support to students in order to be able to estimate associations between these interactions and students' academic outcomes. Ideally, we would have student-level data that allow us to observe which specific students are working directly with aides. However, it was not feasible to obtain these data during the project timeline.²⁰

To approximate this type of activity, we focus our analyses on the subset of aide FTEs that are engaged in teaching activities. We refer to these FTEs as *instructional aides*.

Reading, Writing, and Math Outcomes

We use student assessment data from OSPI as one measure of academic outcomes. This data includes the percent of students in a school that did not meet, met, or exceeded state standards on reading, writing, English language arts, and math exams.²¹

For grades 3–8 and 10–11, we report proficiency levels on state exams as the percent of students in a school that met state standards on math, reading, writing and English language arts exams. Note that the test used to measure proficiency changed during this period; we report results for both the old and new exams.²²

²⁰ A causal relationship can be estimated using school-level data through other types of experiments (e.g. a randomized control trial or instrumental variable analysis). However, these experiments were not feasible during our timeline.

²¹ Level 3 indicates meeting state standards (proficient) while Level 4 indicates exceeding state standards (advanced proficiency). OSPI state testing website.

²² For school years 2009-10 to 2013-14, reading, writing, and math proficiency was assessed in grades 3-8 using the state's Measurements of Student Progress (MSP), while the

Graduation Outcomes

We use OSPI-provided school-level data on graduation rates to calculate our remaining academic outcomes. We report graduation rates as on-time graduation (the percent of students in a school that graduate within four years) and extended graduation (the percent of students in a school that graduate within five years). Our graduation rate analysis was conducted for school years 2010-11 to 2015-16.²³

Other Data

In our analyses we use a variety of data sources to control for other factors that may affect the use of paraeducators or student outcomes, including the following:

- *Student characteristics* from OSPI's report card data files,²⁴ including total enrollment and demographics (e.g., race and ethnicity, low-income status, enrollment in programs like special education).
- *Teacher characteristics* and educator quality from OSPI's report card data files, including the percentage of teachers in a school with a master's degree, the average years of teaching experience among teachers, and the average number of students per classroom teacher.
- *School characteristics*, including school listings from OSPI's education

High School Proficiency Exam (HSPE) assessed reading and writing proficiency in 10th grade. Beginning in school year 2014-15, the Smarter Balanced Assessment (SBA) became the new tool to assess English language arts (formerly reading and writing under the MSP and HSPE) and math proficiency in grades 3-8, and 11.

²³ OSPI changed the way it calculates graduation rates during the 2009-10 school year. To maintain consistency across measures, we analyzed graduation rates from 2010-11 to 2015-16 because they are based on the same underlying calculation. No author. (2012) graduation rate calculations in Washington State.

²⁴ <http://reportcard.ospi.k12.wa.us/DataDownload.aspx>.

directory,²⁵ geographic data from the National Center for Education Statistics,²⁶ and information about schools piloted during assessment rollout and schools that receive federal Title I, Part A funding from OSPI.

- *School staffing information* from OSPI's school personnel data files.²⁷ This data provides staffing levels for instructional aides and other types of school staff (e.g., teachers and administrators), reported as FTE) units calculated assuming full-time employment for a complete academic school year—260 eight-hour work days.

Appendix II contains additional detail about these data and the methods described below.

Methods

Variation in the Use of Paraeducators across Districts and Public Schools

To answer the first research question, we used student demographic information, teacher and school information, and school staffing data from school years 2009-10 to 2015-16. We used a fixed effects regression model to examine which factors, if any, are associated with the number of FTE instructional aides districtwide and schoolwide.

We used school and district fixed effects to control for unobserved and unique school and district characteristics such as school culture, which may be associated with the use of paraeducators. By including school and district fixed effects, we control for

²⁵ List of schools in Washington State.

²⁶ <https://nces.ed.gov/surveys/ruraled/definitions.asp>.

²⁷ School district personnel summary reports.

school-level and district-level characteristics that do not vary over time but may affect the use of paraeducators in a school or districts.

While including school and district fixed effects accounts for time-invariant characteristics within individual schools or districts, it does not control for individual school or district characteristics that vary over our analysis period and also impact the use of paraeducators. To account for characteristics that potentially change over time, we control for student demographics, teacher characteristics, school characteristics, and staffing data.

In addition to school and district fixed effects and time-varying controls, we also include year fixed effects to control for statewide trends that could impact the use of paraeducators during the period of analysis. For example, a rising statewide unemployment rate may affect hiring patterns at schools and district.

Paraeducators and Academic Outcomes

In our analysis of academic outcomes, we pair the data described above with reading, writing, English language arts, and math assessment results and graduation rates to estimate associations between instructional aide FTEs and student academic outcomes at the school level, from school years 2009-10 to 2015-16.²⁸

In an ideal outcome analysis, we would randomly assign classrooms in a school to receive support from an instructional aide and other classrooms to receive regular instruction without support from an instructional aide. We would then compare academic outcomes

between these “treatment” and “control” groups, which would provide an unbiased estimate of the effect of instructional aides on student academic outcomes.

Given that we could not implement such an experiment, and the availability of data during our project timeline did not allow us to identify which students received instructional aide services, we used school-level data for this analysis.

To make the most of school-level data, we used relevant controls as well as school and year fixed effects to account for observed and unobserved variables to the extent possible.

While we adjusted our analysis as best as possible using school and year fixed effects and relevant controls, our reliance on school-level data still precludes our ability to determine a true cause-and-effect relationship between instructional aides and students’ academic outcomes. Given that we cannot observe instructional aides with individual students, our estimates are aggregated with other factors that impact students’ academic outcomes. Any potential impact that instructional aides may have on student academic outcomes is mixed in with these factors and indistinguishable. As a result of these limitations,²⁹ our findings describe the associations between instructional aides and student academic outcomes and do not represent causal relationships.

²⁸ OSPI provided WSIPP with assessment and graduation rate data unsuppressed and aggregated at the school-level.

²⁹ Full detail of limitations in Appendix II.

III. Washington State Variation in the Use of Paraeducators

First we describe statewide trends for aides and a subset of aides (instructional aides) from school years 2009-10 to 2015-16. Then we describe how the use of instructional aides in districts and schools is associated with student demographics, teacher characteristics, and other school factors.

Since individuals can perform multiple roles in schools, we focus on FTE staffing units designated instructional aides in order to best observe personnel specifically providing instructional support to students.

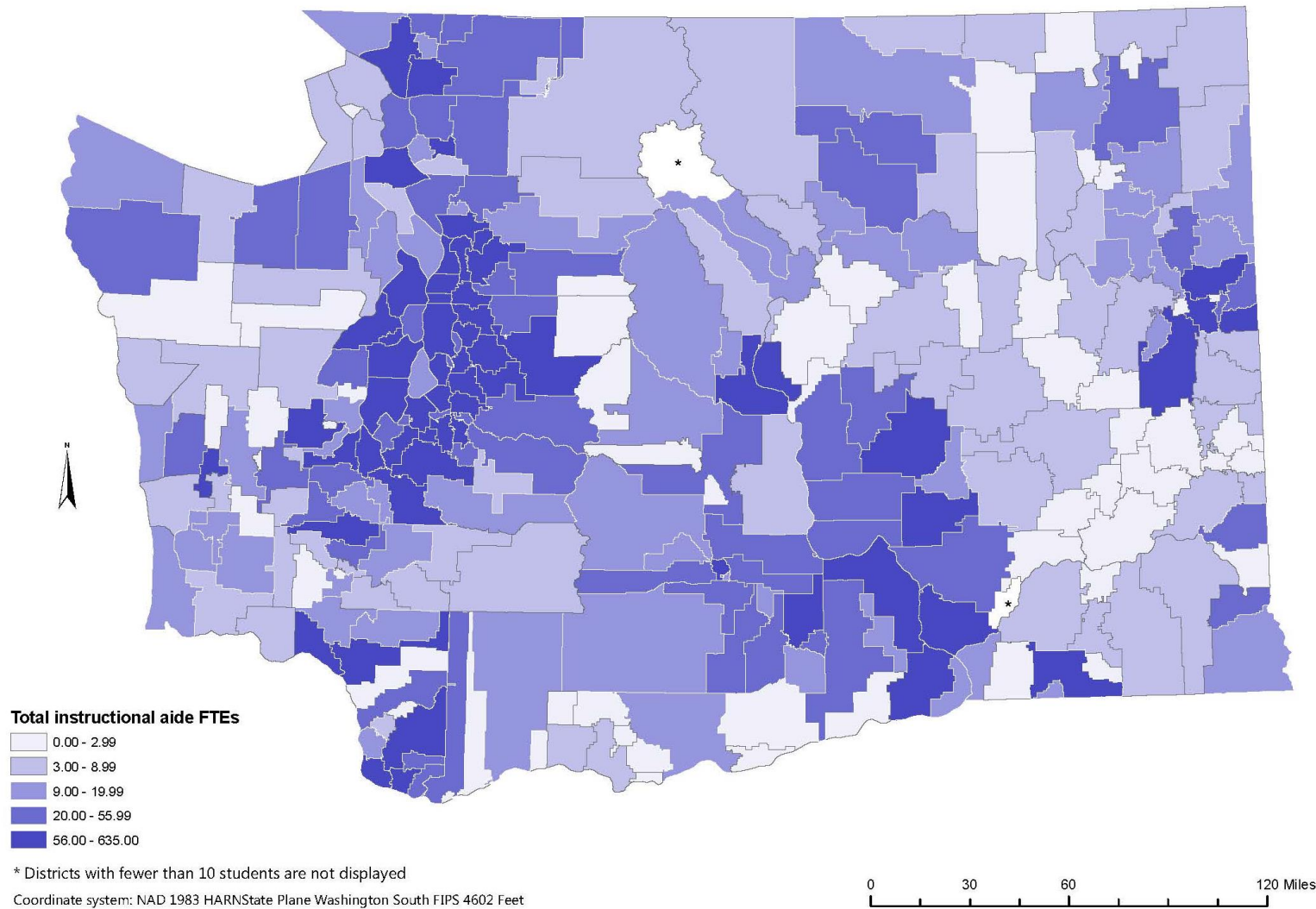
Variation in Districts and Schools

In school year 2015-16, instructional aide FTEs in districts varied widely—ranging from no instructional aides in two districts to 635 instructional aide FTEs in Seattle Public Schools ([Exhibit 6](#)).³⁰ On average, school districts employed 40 instructional aide FTEs.

³⁰ For a complete list of school districts, total enrollment, and the number of instructional aides, please see Exhibit A1 in the Technical Appendix.

Exhibit 6

Instructional Aide FTEs Employed in Each District



Given that school districts with more students also tend to employ more instructional aide FTEs, we also examined instructional aide FTEs per 100 students. With this standardized measure, we found less variation among districts. On average, districts employed 1.3 instructional aide FTEs per 100 students. Among districts that employed any instructional aides, this ranged from 2.7 to 3.7 instructional aide FTEs per 100 students.³¹

For additional information, see [Appendix I](#). At the school level, there was an average of six instructional aide FTEs per school, with a range from no FTEs in 30 schools to 29 FTEs in one elementary school. When examining instructional aide FTEs per 100 students, there was a range of no instructional aide FTEs per 100 students in 20 schools to more than 13 instructional aide FTEs per 100 students in two schools.

Variation across Districts

We present results of our preferred model in Exhibit 7. At the district level, we found that districts with the following characteristics had higher instructional aide FTEs:³²

- higher student enrollment, and
- higher percentage of students in special education.

Additionally, we found that districts with larger average class sizes had fewer instructional aide FTEs.

For example, we found that on average, an increase of one additional student enrolled in a district was associated with 0.014 additional instructional aide FTEs.

Additional statistically significant associations³³ between student and school characteristics and instructional aide FTEs are summarized in [Exhibit 7](#).

³¹ Not including districts with enrollment less than 100 students.

³² In our district level variation analysis, total enrollment and staffing levels were highly collinear. Therefore, we estimated associations between total enrollment and instructional aide FTEs and staffing levels and instructional aide FTEs in separate models, described further in Appendix III.

³³ Statisticians often rely on a metric, the p-value, to determine whether an effect is “significant.” The p-value is a measure of the likelihood that the difference could occur by chance—values range from 0 (highly significant) to 1 (no significant difference). By convention, p-values less than 0.05 (a 5% likelihood that the difference could occur by chance) are considered statistically significant.

Exhibit 7

District-Level Factors that are Significantly Associated with Instructional Aide FTEs

District variables	Change in instructional aide FTE
Total enrollment	0.014*** (0.00)
% in special education programs	0.078** (0.04)
Students per classroom teacher	-0.49*** (0.18)
Adjusted R ²	0.95
No. of districts	292
No. of observations	2,028

Notes:

Robust standard errors in parentheses.

* p-value < 0.10, ** p-value < 0.05, and *** p-value < 0.01.

Variation across Public Schools

At the school level, we found that schools with the following characteristics had higher instructional aide FTEs:

- higher percentage of students in special education,
- higher percentage of students eligible for free or reduced priced meals,
- more classroom teachers,
- more educational staff associates, and
- schools that receive federal Title I, Part A funding.

Additionally, we found that schools with higher proportions of students in the Transitional Bilingual Instruction Program and schools with more administrative staff had fewer instructional aide FTEs.

Again, these are generally small but significant associations. For example, we found that an additional percentage point increase in the proportion of students enrolled in special education was associated with an increase in instructional aides of 0.05 FTEs.

The significant associations between several characteristics and instructional aide FTEs are summarized in [Exhibit 8](#) below. (See [Appendix III](#) for full results.)

Exhibit 8

School-Level Factors that are Significantly Associated with Instructional Aide FTEs

School variables	Change in instructional aide FTE
% in TBIP [^]	-0.03*** (0.01)
% in special education programs	0.05*** (0.01)
% FRMP [#]	0.01*** (0.00)
Educational staff associate FTEs	0.06*** (0.01)
Classroom teacher FTEs	0.14*** (0.01)
Administrative staff FTEs	-0.13* (0.07)
Title I, Part A-funded school	0.22** (0.08)
Adjusted R ²	0.75
No. of schools	1,830
No. of observations	12,191

Notes:

Standard error in parentheses.

* p-value < 0.10, ** p-value < 0.05, and *** p-value < 0.01.

[^] Transitional Bilingual Instruction Program.

[#] Free or reduced-price meal programs.

IV. Paraeducators and Academic Outcomes in Washington

We examined how instructional aide FTEs across school years 2009-10 to 2015-16 are associated with students' achievement on standardized math, reading, writing, and English language arts assessments as well as graduation rates.

After controlling for school and year fixed effects and other relevant school, student, and teacher characteristics, we found very small associations between the number of instructional aide FTEs and the percent of students meeting state standards on math, reading, writing, and English language arts exams. We found no association between instructional aide FTEs and graduation rates. We report only statistically significant results in this section ([Exhibit 9](#)).

Given that we were unable to conduct our analyses using student-level data, our results describe observed associations between instructional aide FTEs and student academic outcomes. Our results do not represent cause-and-effect relationships between instructional aides and student outcomes.

For full results, see [Appendix IV](#).

Math, Reading, Writing, and English Language Arts Proficiency Levels

Between schools years 2009-10 to 2013-14, we found that on average, an increase in the number of instructional aide FTEs is associated with a small increase in the proportion of students in a school meeting proficiency levels on math, reading, and writing measured by the Measurements of Student Progress (MSP) and High School Proficiency Exam (HSPE).^{34,35} We also found that an increase in instructional aide FTEs is associated with a decrease in the percentage of students in a school meeting standards on English language arts exams, measured by the Smarter Balanced Assessment (SBA).³⁶ These results³⁷ are summarized in [Exhibit 9](#).

³⁴ The state standardized exam assessing reading, writing, math and science proficiency in grades 3-8 from school years 2009-10 to 2013-14.

³⁵ The state standardized exam assessing reading and writing proficiency in 10th grade from school years 2009-10 to 2013-14.

³⁶ The current state standardized exam assessing English language arts (formerly reading and writing under the MSP and HSPE) and math in grades 3-8 and 11. SBA was rolled out in school year 2013-14 and fully implemented in 2014-15.

³⁷ These results do not imply cause-and-effect relationships, but rather associations between instructional aide FTEs and student outcomes. See Appendix II for more information about limitations of our analyses and results interpretation.

Exhibit 9

The Percentage Point Change in Proportion of Students Meeting Standards, Given an Increase of One Additional Instructional Aide FTE

Assessment	Test subject	Grade	% change
SBA	ELA	8	-0.27*
MSP	Math	3	0.35*
MSP	Reading	3	0.32**
MSP	Reading	5	0.28*
HSPE	Reading	10	0.31**
HSPE	Writing	10	0.27*

Note:

* p-value < 0.10 ** and p-value < 0.05.

For math, we observed that on average, one additional instructional aide FTE is associated with an increase of less than half of one percentage point in the proportion of students in a school meeting state standards in 3rd grade.

For reading, we observed that on average, an additional instructional aide FTE is associated with an increase of less than half of one percentage point in the proportion of students in a school meeting state standards in 3rd, 5th, and 10th grade.

For writing, we observed that on average, an additional instructional aide FTE is associated with an increase of less than half of one percentage point in the proportion of students in a school meeting state standards in 10th grade.

In school years 2013-14 and 2015-16, we found some evidence to indicate a small association between instructional aides and proficiency levels on the English language arts exam, measured by the SBA. We found that an additional instructional aide FTE is associated with a decrease of less than half

of one percentage point in the proportion of students in a school meeting state standards in 8th grade.

Graduation Rates

We found no evidence of an association between instructional aide FTEs and the proportion of students graduating on time (within four years) or in an extended period of time (within five years).

On the whole, these small and associative results, particularly surrounding reading and math outcomes, mirror findings from our national literature review.

See [Appendix IV](#) for full results.

V. Literature Review and Meta-Analyses

The Washington State Legislature often directs WSIPP to study the effectiveness of programs and policies that could be implemented in Washington State. These studies are designed to provide policymakers with objective information about which programs (also referred to as “policy options”) work to achieve desired outcomes (e.g., improved reading scores).

WSIPP implements a rigorous, standardized research approach to undertake this type of study. We conduct a meta-analysis, a quantitative review of the research literature, to determine if the weight of the research evidence indicates whether desired outcomes, on average, are achieved.

To ensure a rigorous analysis for each program examined, WSIPP follows several key protocols.³⁸

- We search for all studies on a topic. We systematically review the national and international research literature and consider all available studies on a program, regardless of their findings. That is, we do not “cherry pick” studies to include in our analysis.³⁹

- We screen studies for quality. We only include rigorous studies in our analysis. We require that a study reasonably attempt to demonstrate causality using appropriate statistical techniques. For example, studies must include both treatment and comparison groups with an intent-to-treat analysis. Studies that do not meet our minimum standards are excluded from analysis.
- We determine the average effect size. We use a formal set of statistical procedures to calculate an average effect size for each outcome, which indicates the expected magnitude of change caused by the program (e.g., paraeducator provided reading program) for each outcome of interest (e.g., reading test scores).

Programs Reviewed

For this assignment, we searched for paraeducator-provided supplemental education programs using terms including, but not limited to, “paraeducator,” “paraprofessional,” “teaching assistants,” and “instructional aides.” We found 83 studies that examined the relationship between these programs and student outcomes.

[Appendix V](#) contains the list of studies found in our literature review.

³⁸ WSIPP benefits-cost technical documentation.

³⁹ Our literature review in this report was focused on national research literature, as directed by ESHB 1115.

Outcomes Examined

We required that studies measure test scores (reading, math, or both) as the primary outcome of interest in order to be included in this analysis. Several studies reported additional outcomes, like paraeducator performance outcomes (e.g., teacher satisfaction or parent satisfaction with paraeducators); students' social outcomes (e.g., peer interactions, independence, and personal control); pupil interactions with paraeducators; and/or on-task behaviors. We captured all reported outcomes for studies that met our methodological standards of rigor.

Findings

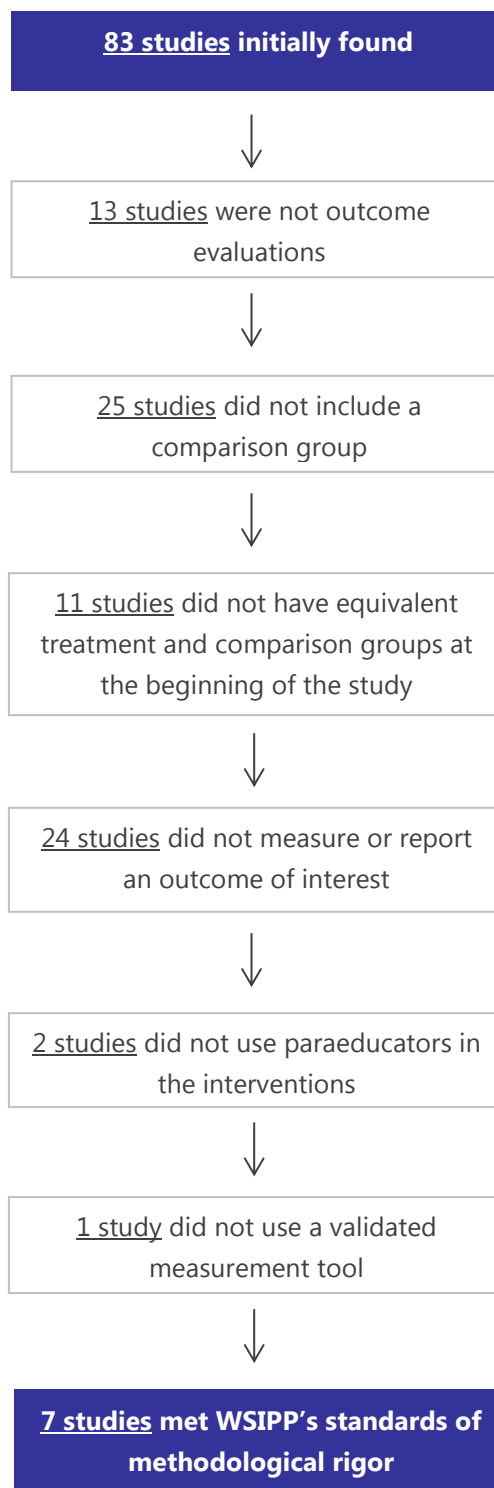
Of the 83 studies in our review, seven met WSIPP's standards of methodological rigor for inclusion in meta-analysis and reported outcomes of interest. [Exhibit 10](#) depicts a flow chart of why studies did not meet WSIPP's standards for methodological rigor.

The seven identified studies focus on three broad types of paraeducator-provided supplemental education programs:

- reading interventions, provided one-on-one or in small groups outside of regular classroom instruction (five studies);
- instructional support provided during regular class hours by paraeducators to students with learning or cognitive disabilities in general education classrooms (one study); and
- instructional support provided one-on-one or in small groups by paraeducators to English language learners outside of regular classrooms (one study).

See [Appendix VI](#) for studies reviewed for inclusion in our meta-analyses.

Exhibit 10



Paraeducator-Delivered Supplemental Reading Programs

In the five studies included in this analysis, students in 2nd and 3rd grade who were identified as at-risk readers⁴⁰ were provided supplemental reading instruction programs delivered by paraeducators.

In one-on-one or small group settings, paraeducators provided students targeted instruction in phonics, fluency, and/or pronunciation training for an average of 30 minutes per day for three to nine months, depending on the program. Students in comparison groups received typical in-classroom instruction from their regular teacher.

In included studies, paraeducators were required to have a minimum of a high school diploma, though all of these studies indicated that the average level of education achieved by paraeducators ranged from some college to an associate's or bachelor's degree. In addition, paraeducators received an initial training for three to four hours and one-on-one training during the length of the program.

In our meta-analysis, we found that paraeducator-delivered supplemental reading programs had no reliable effect on students' reading test scores (Exhibit 11).

⁴⁰ These were students that tested at least one grade below standard reading level.

Exhibit 11

Meta-Analytic Findings: Paraeducator-Delivered Supplemental Reading Programs

# of effect sizes	Average effect size	Standard error	P-value	Treatment sample
5	0.15	0.12	0.20	253

Paraeducators in General Classrooms

We found one study that met our methodological standards of for meta-analysis. It focused on paraeducators providing instructional assistance to all students (regardless of need) in general education classrooms. The Student-Teacher Achievement Ratio (STAR) project was a four-year longitudinal class-size study in Tennessee that examined the math and reading test scores of Kindergarten through 3rd grade students randomly assigned to three conditions: placement in a regular classroom, placement in a regular classroom with a paraeducator, and placement in a small classroom.

This study found a small and significantly positive effect on students' math and reading test scores in 1st and 2nd grade in the condition with a paraeducator, compared to students in a regular classroom without a paraeducator. There was no reliable effect on students' math and reading test scores in Kindergarten or 3rd grade (Exhibit 12).⁴¹

⁴¹ We report the most relevant finding for this report. This study also reported that students in small classrooms with no paraeducators had higher math and reading scores than students in regular classrooms with paraeducators.

Exhibit 12

Effect Sizes by Grade Level: Paraeducators in General Classrooms
Compared to General Education Classrooms without Paraeducators

Grade	Average effect size	Standard error	P-value	Treatment sample
Kindergarten	0.03	0.03	0.40	1,914
1 st	0.09	0.03	0.01	1,808
2 nd	0.07	0.03	0.04	1,795
3 rd	0.01	0.03	0.81	1,743

While this study employed random assignment and contained large sample sizes, the results should be interpreted with caution as they represent findings from a single study.

Paraeducators Working with English Language Learners

Finally, one study that met our standards of methodological rigor focused on paraeducators working with English language learners.

In this study, bilingual paraeducators provided instructional support to English language learners that had scored below grade level on English proficiency exams. Paraeducators worked with students in both one-on-one and small group settings outside of the regular classroom. In this study, the program had no reliable effect on students' reading test scores.

We did not present the effect size from this analysis because the study was quasi-experimental and had a small treatment sample size. If additional similar studies are published in the future, this study could be included in a larger meta-analysis.

VI. Summary

We address three basic research questions in this report:

- 1) How does the use of instructional aides vary across the state?
- 2) To the extent possible, is the use of instructional aides associated with students' academic outcomes?
- 3) What does the national research literature say about the impact of paraeducators on student outcomes?

To answer the first question, we used student, teacher, and staffing data from OSPI to examine how district- and school-level factors are associated with instructional aide FTEs during school years 2009-10 to 2015-16.

When examining what factors at the district and school levels are associated with the number of instructional aide FTEs, we found that at the district level, higher student enrollment and a higher proportion of students in special education were associated with statistically significant increases in instructional aide FTEs. Districts with larger average class sizes had fewer instructional aide FTEs.

At the school level, the proportion of students in special education, the proportion of students eligible for free or reduced-price meals, classroom teacher, educational staff levels, and Title I, Part A funding were also associated with small but statistically significant increases in instructional aide FTEs.

Alternatively, higher proportions of students in the Transitional Bilingual Instruction Program and increases in administrative

staffing levels were both associated with small, but statistically significant decreases in instructional aide FTEs.

To answer the second question, we used student, teacher, and staffing data along with assessment and graduation rate data to examine the association between instructional aide FTEs and student academic outcomes from school years 2009-10 to 2015-16. We found very small associations between instructional aide FTEs and the percentage of students meeting state standards on math, reading, writing, and English language arts exams in some grades. We did not find any significant associations between instructional aide FTEs and graduation rates.

Since we were unable to conduct our analysis using student-level data, our results describe observed associations between instructional aide FTEs and student academic outcomes. Our results do not represent cause-and-effect relationships. Additionally, findings from this analysis cannot be generalized beyond public schools and our definition of instructional aide may not capture all forms of paraeducators working in classrooms in Washington public schools.

Finally, to answer the third question, we conducted a national literature review of studies that examined the effectiveness of paraeducators on student outcomes. In our review, we found 83 studies that focused on paraeducator-provided supplemental instructional programs, for students at risk of not meeting grade-level standards in certain subjects, students that had learning

or cognitive disabilities, and students in general education classrooms.

From this review, seven studies met our standards for methodological rigor to be included in meta-analysis. Five of these studies examined students in 2nd and 3rd grades who were at risk of not meeting reading standards. These students received supplemental reading instruction programs provided by paraeducators. Through a meta-analysis, we found that this paraeducator-delivered supplemental reading program did not have a reliable effect on students' reading test scores.

One additional study provided some evidence of positive effects and some evidence of null effects (depending on grade level) on students' math and reading test scores when in general education classrooms with paraeducators, compared to students in regular classrooms without paraeducators. Another study found some evidence of null effects of bilingual paraeducators working with English language learner students on reading test scores. However, these findings should be interpreted with caution as they are reported from single studies and may not generalize to a broader context.



Appendices

Paraeducators: Statewide Variation and Association with Academic Outcomes

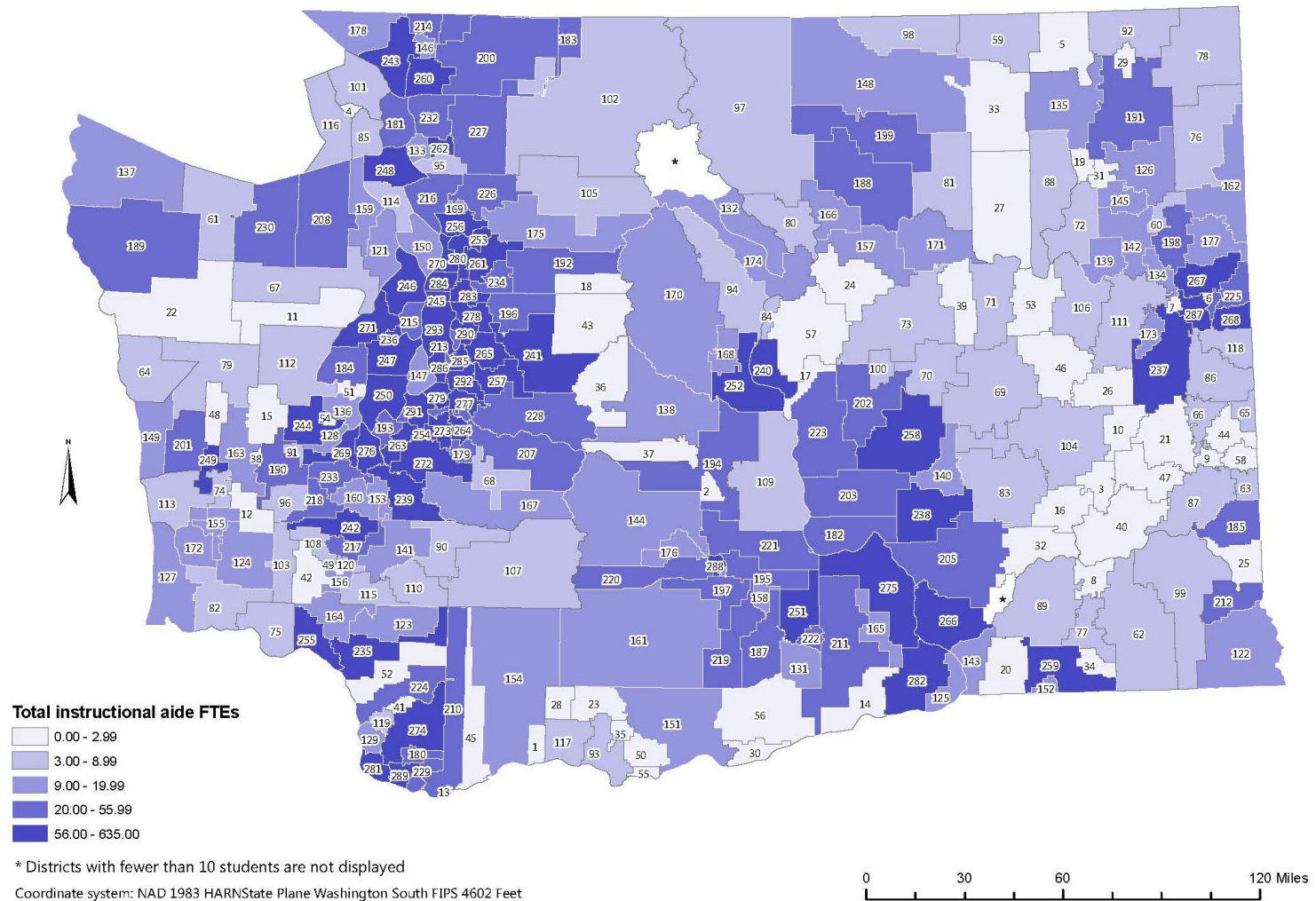
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I. Instructional Aide FTEs and FTEs per 100 Students by School District

Exhibit A1

Instructional Aide FTEs by District
(Number in District Corresponds to Map ID # in Table Below)



Map #	School district	Total enrollment	Instructional aide (FTE)	Map #	School district	Total enrollment	Instructional aide (FTE)
1	Mill A	17	0	51	Grapeview	229	2.45
2	Damman	40	0	52	Kalama	925	2.48
3	Benge	13	0.15	53	Creston	88	2.53
4	Shaw Island	16	0.19	54	Southside	190	2.56
5	Orient	77	0.25	55	Wishram	78	2.64
6	Orchard Prairie	87	0.26	56	Bickleton	86	2.77
7	Great Northern	48	0.48	57	Waterville	280	2.91
8	Starbuck	30	0.56	58	Garfield	116	2.92
9	Steptoe	43	0.66	59	Curlew	169	3.15
10	Lamont	32	0.71	60	Loon Lake	227	3.25
11	Brinnon	54	0.77	61	Crescent	272	3.34
12	North River	63	0.84	62	Dayton	399	3.36
13	Mount Pleasant	47	0.91	63	Palouse	183	3.41
14	Paterson	136	0.97	64	Taholah	186	3.43
15	Mary M Knight	156	1.05	65	Tekoa	194	3.46
16	Washtucna	41	1.06	66	Rosalia	181	3.48
17	Palisades	32	1.09	67	Quilcene	323	3.49
18	Index	43	1.12	68	Carbonado	179	3.56
19	Evergreen (Stevens)	25	1.23	69	Odessa	232	3.63
20	Touchet	225	1.28	70	Wilson Creek	156	3.86
21	St. John	161	1.34	71	Wilbur	283	3.86
22	Queets-Clearwater	19	1.35	72	Columbia (Stevens)	161	3.92
23	Glenwood	66	1.42	73	Coulee-Hartline	155	3.93
24	Mansfield	96	1.43	74	Cosmopolis	147	3.96
25	Colton	158	1.44	75	Wahkiakum	458	4.09
26	Sprague	69	1.45	76	Cusick	239	4.12
27	Keller	31	1.53	77	Waitsburg	285	4.16
28	Trout Lake	206	1.57	78	Selkirk	258	4.27
29	Onion Creek	40	1.58	79	Lake Quinault	173	4.43
30	Roosevelt	27	1.60	80	Pateros	272	4.45
31	Summit Valley	61	1.62	81	Nespelem	120	4.46
32	Kahlotus	46	1.63	82	Naselle-Grays River Valley	436	4.52
33	Republic	333	1.73	83	Lind	191	4.56
34	Dixie	28	1.77	84	Orondo	156	4.61
35	Klickitat	76	1.77	85	Lopez	242	4.70
36	Easton	113	1.80	86	Liberty	446	4.72
37	Thorp	121	1.80	87	Colfax	599	4.76
38	Satsop	67	1.94	88	Inchelium	213	4.79
39	Almira	109	1.94	89	Prescott	333	4.82
40	LaCrosse	69	1.99	90	Morton	321	4.85
41	Green Mountain	159	1.99	91	McCleary	305	5.16
42	Boistfort	93	2.03	92	Northport	225	5.19
43	Skykomish	43	2.04	93	Lyle	251	5.39
44	Oakesdale	104	2.06	94	Entiat	342	5.70
45	Skamania	76	2.10	95	Conway	440	5.74
46	Harrington	89	2.13	96	Oakville	228	5.80
47	Endicott	102	2.18	97	Methow Valley	612	5.91
48	Wishkah Valley	151	2.25	98	Oroville	569	5.94
49	Evaline	50	2.28	99	Pomeroy	385	5.95
50	Centerville	84	2.29	100	Soap Lake	511	6.32

Map #	School district	Total enrollment	Instructional aide (FTE)	Map #	School district	Total enrollment	Instructional aide (FTE)
101	Orcas Island	839	6.53	151	Goldendale	873	14.30
102	Concrete	529	6.56	152	College Place	1,200	15.18
103	Pe Ell	274	6.66	153	Rainier	803	15.32
104	Ritzville	361	6.67	154	Stevenson-Carson	929	15.54
105	Darrington	429	6.95	155	Raymond	617	15.61
106	Davenport	597	7.17	156	Winlock	664	15.64
107	White Pass	436	7.39	157	Bridgeport	891	15.72
108	Adna	632	7.42	158	Zillah	1,357	15.84
109	Kittitas	661	7.55	159	Port Townsend	1,176	16.07
110	Mossyrock	516	7.88	160	Tenino	1,206	16.15
111	Reardan-Edwall	514	8.01	161	Mount Adams	951	16.22
112	Hood Canal	310	8.10	162	Newport	1,086	16.28
113	Ocosta	615	8.31	163	Montesano	1,383	16.78
114	Coupeville	960	8.51	164	Castle Rock	1,230	18.11
115	Toledo	759	8.59	165	Kiona-Benton City	1,482	18.17
116	San Juan Island	802	8.59	166	Brewster	983	18.26
117	White Salmon Valley	1,291	8.80	167	Eatonville	1,951	18.42
118	Freeman	816	8.86	168	Cashmere	1,534	18.57
119	La Center	1,644	8.87	169	Lakewood	2,315	18.76
120	Napavine	796	8.88	170	Cascade	1,325	18.90
121	Chimacum	1,077	9.18	171	Grand Coulee Dam	719	18.95
122	Asotin-Anatone	653	9.38	172	South Bend	605	18.97
123	Toutle Lake	629	9.66	173	Medical Lake	1,909	19.08
124	Willapa Valley	340	9.81	174	Lake Chelan	1,427	19.22
125	Finley	912	9.91	175	Granite Falls	2,043	19.37
126	Chewelah	806	9.92	176	Highland	1,168	19.48
127	Ocean Beach	1,023	10.12	177	Riverside	1,470	19.49
128	Griffin	659	10.13	178	Blaine	2,198	19.87
129	Ridgefield	2,500	10.15	179	Orting	2,498	20.01
130	Union Gap	651	10.39	180	Hockinson	1,874	20.19
131	Mabton	961	10.43	181	Anacortes	2,811	20.66
132	Manson	668	10.57	182	Wahluke	2,370	22.60
133	La Conner	627	10.74	183	Nooksack Valley	1,619	23.48
134	Nine Mile Falls	1,449	10.95	184	North Mason	2,170	23.85
135	Kettle Falls	912	11.08	185	Pullman	2,838	24.27
136	Pioneer	688	11.16	186	Dieringer	1,556	24.71
137	Cape Flattery	475	11.20	187	Granger	1,526	24.83
138	Cle Elum-Roslyn	903	11.23	188	Okanogan	1,110	24.96
139	Wellpinit	466	11.43	189	Quillayute Valley	3,094	25.20
140	Warden	982	11.69	190	Elma	1,430	25.23
141	Onalaska	760	11.87	191	Colville	1,811	26.36
142	Mary Walker	484	11.91	192	Sultan	1,970	26.63
143	Columbia (Walla Walla)	835	12.11	193	Steilacoom Hist.	3,169	28.09
144	Naches Valley	1,343	12.47	194	Ellensburg	3,238	28.13
145	Valley	704	12.83	195	East Valley (Yakima)	3,129	28.59
146	Meridian	1,757	13.25	196	Riverview	3,247	28.86
147	Vashon Island	1,581	13.26	197	Wapato	3,385	29.17
148	Tonasket	1,139	13.51	198	Deer Park	2,490	29.46
149	North Beach	670	13.63	199	Omak	5,428	30.28
150	South Whidbey	1,415	14.20	200	Mount Baker	1,932	30.96

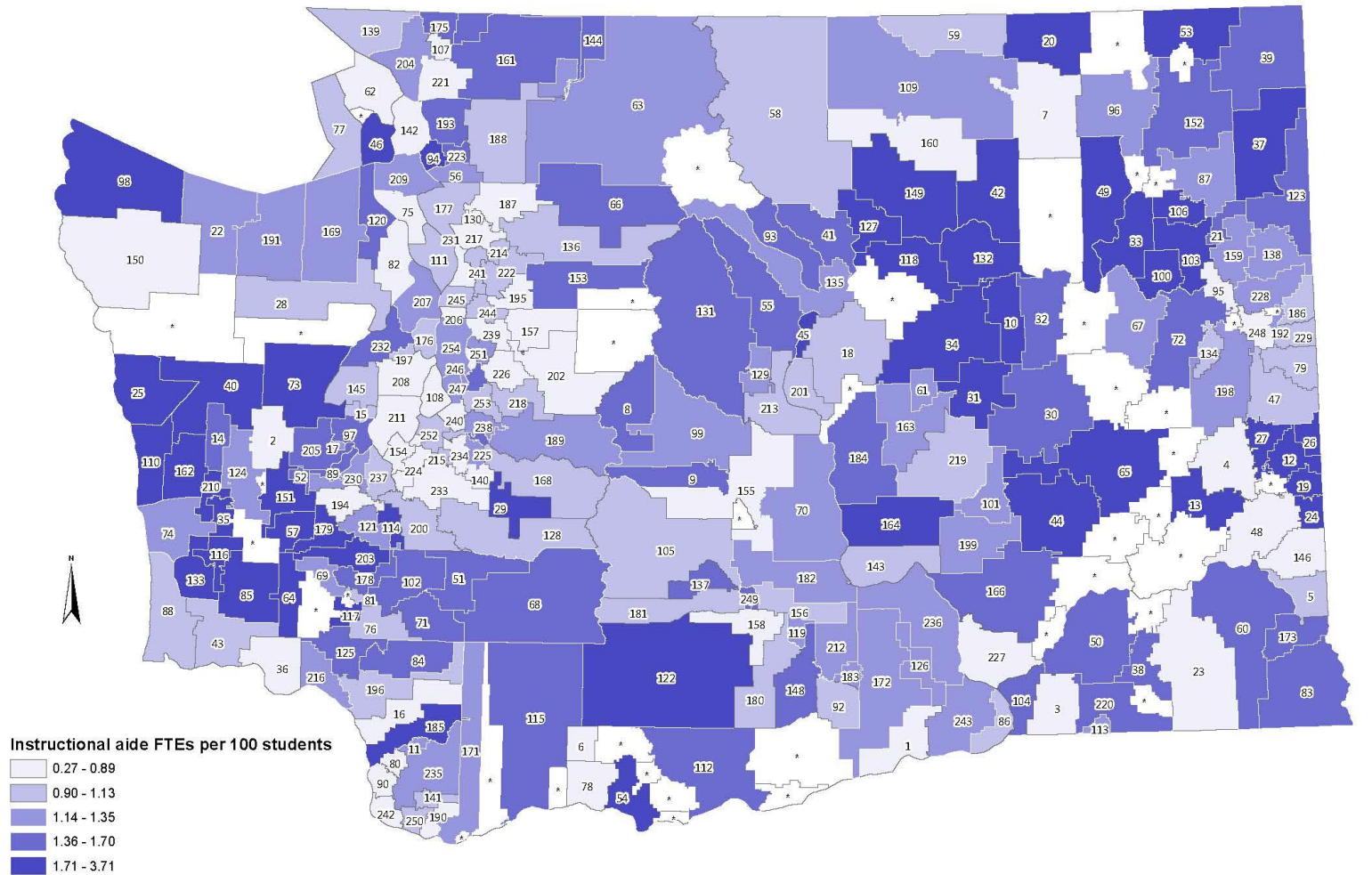
Map #	School district	Total enrollment	Instructional aide (FTE)	Map #	School district	Total enrollment	Instructional aide (FTE)
201	Hoquiam	1,696	31.05	251	Sunnyside	6,809	81.82
202	Ephrata	2,412	32.29	252	Wenatchee	7,962	82.38
203	Royal	1,741	32.43	253	Lake Stevens	8,577	82.89
204	University Place	5,633	32.82	254	Franklin Pierce	7,740	83.17
205	North Franklin	2,111	34.03	255	Longview	6,864	83.65
206	Fife	3,697	34.12	256	Marysville	11,211	85.97
207	White River	3,623	34.57	257	Tahoma	8,178	89.76
208	Sequim	2,850	35.12	258	Moses Lake	8,353	90.34
209	Tukwila	3,041	35.69	259	Walla Walla	5,919	91.36
210	Washougal	3,199	36.56	260	Bellingham	11,287	94.73
211	Prosser	2,825	36.81	261	Snohomish	10,139	95.08
212	Clarkston	2,679	37.00	262	Mount Vernon	6,755	98.54
213	Mercer Island	4,446	37.16	263	Clover Park	12,811	108.96
214	Lynden	2,866	39.69	264	Sumner	9,230	115.96
215	Bainbridge Island	3,909	40.72	265	Issaquah	19,815	124.26
216	Stanwood-Camano	4,493	42.09	266	Pasco	17,441	125.50
217	Chehalis	3,023	42.15	267	Mead	9,876	126.36
218	Rochester	2,193	42.68	268	Central Valley	13,402	127.29
219	Toppenish	4,410	43.99	269	Olympia	9,971	127.97
220	West Valley (Yakima)	5,038	45.61	270	Mukilteo	15,359	134.61
221	Selah	3,618	45.89	271	Central Kitsap	10,967	149.27
222	Grandview	3,703	46.30	272	Bethel	18,819	149.63
223	Quincy	2,921	46.92	273	Puyallup	22,098	160.83
224	Woodland	2,336	47.04	274	Battle Ground	13,506	161.96
225	East Valley (Spokane)	4,273	47.49	275	Richland	13,188	162.30
226	Arlington	5,548	47.50	276	North Thurston	14,869	168.52
227	Sedro-Woolley	4,344	47.88	277	Auburn	15,825	188.02
228	Enumclaw	4,062	48.05	278	Lake Washington	27,731	188.61
229	Camas	6,900	50.18	279	Federal Way	22,930	191.28
230	Port Angeles	3,834	50.87	280	Everett	19,957	193.14
231	West Valley (Spokane)	3,780	50.90	281	Vancouver	23,504	203.26
232	Burlington-Edison	3,682	50.98	282	Kennewick	17,722	205.59
233	Tumwater	6,401	51.42	283	Northshore	21,458	208.85
234	Monroe	7,002	54.80	284	Edmonds	20,923	214.90
235	Kelso	5,002	56.05	285	Renton	15,836	219.76
236	Bremerton	5,182	56.22	286	Highline	19,576	222.17
237	Cheney	4,551	56.73	287	Spokane	30,463	223.42
238	Othello	4,282	57.02	288	Yakima	16,238	237.50
239	Yelm	5,708	57.89	289	Evergreen (Clark)	26,023	248.51
240	Eastmont	5,966	58.04	290	Bellevue	20,054	259.72
241	Snoqualmie Valley	6,881	61.20	291	Tacoma	29,313	288.92
242	Centralia	3,587	63.76	292	Kent	27,736	313.79
243	Ferndale	4,789	64.49	293	Seattle	53,343	634.84
244	Shelton	4,310	67.53	294	Stehekin	*	*
245	Shoreline	9,231	68.42	295	Star No. 054	*	*
246	North Kitsap	6,107	70.54				
247	South Kitsap	9,702	71.72				
248	Oak Harbor	5,811	72.83				
249	Aberdeen	3,270	74.43				
250	Peninsula	8,927	74.84				

Note:

Districts with ten or fewer students are not displayed.

Exhibit A2

Instructional Aide FTE per 100 Students by District
(Number in District Corresponds to Map ID # in Table Below)



* school districts with fewer than 100 students are not displayed

Coordinate system: NAD_1983_HARN_StatePlane_Washington_South_FIPS_4602_Feet

0 30 60 120 Miles

Map #	School district	Total enrollment	Instructional aide (FTE)	Map #	School district	Total enrollment	Instructional aide (FTE)
1	Paterson	136	0.71	51	Morton	321	1.51
2	Mary M Knight	156	0.67	52	McCleary	305	1.69
3	Touchet	225	0.57	53	Northport	225	2.31
4	St. John	161	0.83	54	Lyle	251	2.15
5	Colton	158	0.91	55	Entiat	342	1.67
6	Trout Lake	206	0.76	56	Conway	440	1.30
7	Republic	333	0.52	57	Oakville	228	2.54
8	Easton	113	1.59	58	Methow Valley	612	0.97
9	Thorp	121	1.49	59	Oroville	569	1.04
10	Almira	109	1.78	60	Pomeroy	385	1.55
11	Green Mountain	159	1.25	61	Soap Lake	511	1.24
12	Oakesdale	104	1.98	62	Orcas Island	839	0.78
13	Endicott	102	2.14	63	Concrete	529	1.24
14	Wishkah Valley	151	1.49	64	Pe Ell	274	2.43
15	Grapeview	229	1.07	65	Ritzville	361	1.85
16	Kalama	925	0.27	66	Darrington	429	1.62
17	Southside	190	1.35	67	Davenport	597	1.20
18	Waterville	280	1.04	68	White Pass	436	1.69
19	Garfield	116	2.52	69	Adna	632	1.17
20	Curlew	169	1.86	70	Kittitas	661	1.14
21	Loon Lake	227	1.43	71	Mossyrock	516	1.53
22	Crescent	272	1.23	72	Reardan-Edwall	514	1.56
23	Dayton	399	0.84	73	Hood Canal	310	2.61
24	Palouse	183	1.86	74	Ocosta	615	1.35
25	Taholah	186	1.84	75	Coupeville	960	0.89
26	Tekoa	194	1.78	76	Toledo	759	1.13
27	Rosalia	181	1.92	77	San Juan Island	802	1.07
28	Quilcene	323	1.08	78	White Salmon Valley	1,291	0.68
29	Carbonado	179	1.99	79	Freeman	816	1.09
30	Odessa	232	1.56	80	La Center	1,644	0.54
31	Wilson Creek	156	2.47	81	Napavine	796	1.12
32	Wilbur	283	1.36	82	Chimacum	1,077	0.85
33	Columbia (Stevens)	161	2.43	83	Asotin-Anatone	653	1.44
34	Coulee-Hartline	155	2.54	84	Toutle Lake	629	1.54
35	Cosmopolis	147	2.69	85	Willapa Valley	340	2.89
36	Wahkiakum	458	0.89	86	Finley	912	1.09
37	Cusick	239	1.72	87	Chewelah	806	1.23
38	Waitsburg	285	1.46	88	Ocean Beach	1,023	0.99
39	Selkirk	258	1.66	89	Griffin	659	1.54
40	Lake Quinalt	173	2.56	90	Ridgefield	2,500	0.41
41	Pateros	272	1.64	91	Union Gap	651	1.60
42	Nespelem	120	3.72	92	Mabton	961	1.09
43	Naselle-Grays River Valley	436	1.04	93	Manson	668	1.58
44	Lind	191	2.39	94	La Conner	627	1.71
45	Orondo	156	2.96	95	Nine Mile Falls	1,449	0.76
46	Lopez	242	1.94	96	Kettle Falls	912	1.21
47	Liberty	446	1.06	97	Pioneer	688	1.62
48	Colfax	599	0.79	98	Cape Flattery	475	2.36
49	Inchelium	213	2.25	99	Cle Elum-Roslyn	903	1.24
50	Prescott	333	1.45	100	Wellpinit	466	2.45

Map #	School district	Total enrollment	Instructional aide (FTE)	Map #	School district	Total enrollment	Instructional aide (FTE)
101	Warden	982	1.19	151	Elma	1,430	1.76
102	Onalaska	760	1.56	152	Colville	1,811	1.46
103	Mary Walker	484	2.46	153	Sultan	1,970	1.35
104	Columbia (Walla Walla)	835	1.45	154	Steilacoom Hist.	3,169	0.89
105	Naches Valley	1,343	0.93	155	Ellensburg	3,238	0.87
106	Valley	704	1.82	156	East Valley (Yakima)	3,129	0.91
107	Meridian	1,757	0.75	157	Riverview	3,247	0.89
108	Vashon Island	1,581	0.84	158	Wapato	3,385	0.86
109	Tonasket	1,139	1.19	159	Deer Park	2,490	1.18
110	North Beach	670	2.03	160	Omak	5,428	0.56
111	South Whidbey	1,415	1.00	161	Mount Baker	1,932	1.60
112	Goldendale	873	1.64	162	Hoquiam	1,696	1.83
113	College Place	1,200	1.27	163	Ephrata	2,412	1.34
114	Rainier	803	1.91	164	Royal	1,741	1.86
115	Stevenson-Carson	929	1.67	165	University Place	5,633	0.58
116	Raymond	617	2.53	166	North Franklin	2,111	1.61
117	Winlock	664	2.36	167	Fife	3,697	0.92
118	Bridgeport	891	1.76	168	White River	3,623	0.95
119	Zillah	1,357	1.17	169	Sequim	2,850	1.23
120	Port Townsend	1,176	1.37	170	Tukwila	3,041	1.17
121	Tenino	1,206	1.34	171	Washougal	3,199	1.14
122	Mount Adams	951	1.71	172	Prosser	2,825	1.30
123	Newport	1,086	1.50	173	Clarkston	2,679	1.38
124	Montesano	1,383	1.21	174	Mercer Island	4,446	0.84
125	Castle Rock	1,230	1.47	175	Lynden	2,866	1.38
126	Kiona-Benton City	1,482	1.23	176	Bainbridge Island	3,909	1.04
127	Brewster	983	1.86	177	Stanwood-Camano	4,493	0.94
128	Eatonville	1,951	0.94	178	Chehalis	3,023	1.39
129	Cashmere	1,534	1.21	179	Rochester	2,193	1.95
130	Lakewood	2,315	0.81	180	Toppenish	4,410	1.00
131	Cascade	1,325	1.43	181	West Valley (Yakima)	5,038	0.91
132	Grand Coulee Dam	719	2.64	182	Selah	3,618	1.27
133	South Bend	605	3.14	183	Grandview	3,703	1.25
134	Medical Lake	1,909	1.00	184	Quincy	2,921	1.61
135	Lake Chelan	1,427	1.35	185	Woodland	2,336	2.01
136	Granite Falls	2,043	0.95	186	East Valley (Spokane)	4,273	1.11
137	Highland	1,168	1.67	187	Arlington	5,548	0.86
138	Riverside	1,470	1.33	188	Sedro-Woolley	4,344	1.10
139	Blaine	2,198	0.90	189	Enumclaw	4,062	1.18
140	Orting	2,498	0.80	190	Camas	6,900	0.73
141	Hockinson	1,874	1.08	191	Port Angeles	3,834	1.33
142	Anacortes	2,811	0.73	192	West Valley (Spokane)	3,780	1.35
143	Wahluke	2,370	0.95	193	Burlington-Edison	3,682	1.38
144	Nooksack Valley	1,619	1.45	194	Tumwater	6,401	0.80
145	North Mason	2,170	1.10	195	Monroe	7,002	0.78
146	Pullman	2,838	0.86	196	Kelso	5,002	1.12
147	Dieringer	1,556	1.59	197	Bremerton	5,182	1.08
148	Granger	1,526	1.63	198	Cheney	4,551	1.25
149	Okanogan	1,110	2.25	199	Othello	4,282	1.33
150	Quillayute Valley	3,094	0.81	200	Yelm	5,708	1.01

Map #	School district	Total enrollment	Instructional aide (FTE)	Map #	School district	Total enrollment	Instructional aide (FTE)
201	Eastmont	5,966	0.97	251	Bellevue	20,054	1.30
202	Snoqualmie Valley	6,881	0.89	252	Tacoma	29,313	0.99
203	Centralia	3,587	1.78	253	Kent	27,736	1.13
204	Ferndale	4,789	1.35	254	Seattle	53,343	1.19
205	Shelton	4,310	1.57	*	Benge	-	-
206	Shoreline	9,231	0.74	*	Shaw Island	-	-
207	North Kitsap	6,107	1.16	*	Mill A	-	-
208	South Kitsap	9,702	0.74	*	Queets-Clearwater	-	-
209	Oak Harbor	5,811	1.25	*	Evergreen (Stevens)	-	-
210	Aberdeen	3,270	2.28	*	Roosevelt	-	-
211	Peninsula	8,927	0.84	*	Dixie	-	-
212	Sunnyside	6,809	1.20	*	Starbuck	-	-
213	Wenatchee	7,962	1.03	*	Keller	-	-
214	Lake Stevens	8,577	0.97	*	Lamont	-	-
215	Franklin Pierce	7,740	1.07	*	Palisades	-	-
216	Longview	6,864	1.22	*	Damman	-	-
217	Marysville	11,211	0.77	*	Onion Creek	-	-
218	Tahoma	8,178	1.10	*	Washtucna	-	-
219	Moses Lake	8,353	1.08	*	Steptoe	-	-
220	Walla Walla	5,919	1.54	*	Index	-	-
221	Bellingham	11,287	0.84	*	Skykomish	-	-
222	Snohomish	10,139	0.94	*	Kahlotus	-	-
223	Mount Vernon	6,755	1.46	*	Mount Pleasant	-	-
224	Clover Park	12,811	0.85	*	Great Northern	-	-
225	Sumner	9,230	1.26	*	Evaline	-	-
226	Issaquah	19,815	0.63	*	Brinnon	-	-
227	Pasco	17,441	0.72	*	Summit Valley	-	-
228	Mead	9,876	1.28	*	North River	-	-
229	Central Valley	13,402	0.95	*	Glenwood	-	-
230	Olympia	9,971	1.28	*	Satsop	-	-
231	Mukilteo	15,359	0.88	*	Sprague	-	-
232	Central Kitsap	10,967	1.36	*	LaCrosse	-	-
233	Bethel	18,819	0.80	*	Klickitat	-	-
234	Puyallup	22,098	0.73	*	Skamania	-	-
235	Battle Ground	13,506	1.20	*	Orient	-	-
236	Richland	13,188	1.23	*	Wishram	-	-
237	North Thurston	14,869	1.13	*	Centerville	-	-
238	Auburn	15,825	1.19	*	Bickleton	-	-
239	Lake Washington	27,731	0.68	*	Orchard Prairie	-	-
240	Federal Way	22,930	0.83	*	Creston	-	-
241	Everett	19,957	0.97	*	Harrington	-	-
242	Vancouver	23,504	0.86	*	Boistfort	-	-
243	Kennewick	17,722	1.16	*	Mansfield	-	-
244	Northshore	21,458	0.97	*	Stehekin	-	-
245	Edmonds	20,923	1.03	*	Star No. 054	-	-
246	Renton	15,836	1.39				
247	Highline	19,576	1.13				
248	Spokane	30,463	0.73				
249	Yakima	16,238	1.46				
250	Evergreen (Clark)	26,023	0.95				

Note:

Districts with 100 or fewer students are not displayed.

II. Data and Methods for Analyses of Variation and Academic Outcomes

Data

For our variation and outcome analyses, we used publically available report card data files on OSPI's website, which provided us with the following student and teacher information:⁴²

- *Student demographics* aggregated at the school level, including total enrollment; the percent of students that are male; the percent of students that identify as American Indian, African American, Asian, Pacific Islander, Hispanic, two or more races,⁴³ and Caucasian; the percent of students that are low-income (eligible for the free or reduced-price meal program); the percent of students enrolled in special education; and the percent of students that are English language learners (enrolled in the state Transitional Bilingual Instructional Program).
- *Teacher characteristics* aggregated at the school level, including the percent of teachers in a school with a master's degree; the average number of years of educational experience among teachers; and the average number of students per classroom teacher.

We also received school information from the following sources:

- OSPI's Education Directory provides a list of districts and schools in Washington State, which allowed us to identify public schools and determine grade spans in specific schools.⁴⁴
- The National Center for Education Statistics' urban-centric data, which enabled us to determine if schools were located in cities, suburbs, towns, or rural areas.⁴⁵
- OSPI also provided data that allowed us to determine which schools received federal Title I funding. Title I Part A is a federal program that provides funding to school districts and individual schools with a large proportion of low-income students in order to provide academic programs and services that ensure a "fair, equitable, and high-quality education" for all students.⁴⁶ Paraeducators working in schools that receive Title I funding are required to meet different standards than paraeducators working in non-Title I served schools.⁴⁷ We control for whether or not schools received Title I funding because Title I funding and associated paraeducator requirements may impact the quality of paraeducators and number of paraeducators working in schools, and therefore, impact student test scores and graduation rates differently than in non-Title I funded schools.
- OSPI also provided WSIPP with information to identify schools piloted during the rollout of the Smarter Balanced Assessment in 2013-14. In 2013-14, students in nearly 30% of public schools did not receive the MSP for reading, writing, or math and instead were administered the Smarter Balanced Assessment. We control for these field-test schools in our analysis.

Additionally, we used OSPI's school personnel data files to identify staffing levels in public schools, measured in full-time equivalent (FTE) staffing units.⁴⁸ Staffing in these personnel files are assigned by

⁴² OSPI report card data.

⁴³ Excluding Caucasian.

⁴⁴ OSPI school directory.

⁴⁵ Geographic location retrieved from <https://nces.ed.gov/ccd/elsi/> and <https://nces.ed.gov/surveys/ruraled/definitions.asp>.

⁴⁶ U.S. Department of Education website. Title I, Part A information. <https://www2.ed.gov/programs/titleiparta/index.html%20http://www.k12.wa.us/TitleI/default.aspx>.

⁴⁷ OSPI Title I, Part A guide to paraeducator requirements.

⁴⁸ Assuming paraeducators do not work during summer breaks, FTE assumes 260 work days, 8 hours a day.

OSPI-defined duties,⁴⁹ activities,⁵⁰ and programs⁵¹ for district accounting purposes. We defined types of staff in the following ways:

- *Aides*: "Assist classroom teachers or staff members performing professional educational teaching assignments on a regularly scheduled basis. Includes teacher aides, classroom attendants, bus monitors, lunchroom aides, community service aides, etc."⁵²
- *Instructional aides*: Aides assigned to work in teaching activities solely.⁵³
- *Classroom teachers*: Certificated teachers in elementary and secondary schools.⁵⁴
- *Certificated administrative staff*: School staff including superintendents, principals, and administrators.⁵⁵
- *Educational staff associates*: Other school staff including nurses, librarians, counselors, social workers, etc.⁵⁶

Finally, for our outcome analysis, OSPI provided WSIPP with unsuppressed assessment and graduation rate data aggregated at the school-level which we describe below.

Assessment Data

These data files included the percent of students in a given public school that met state standards, did not meet state standards, and exceeded state standards on several state standardized tests, including the Smarter Balanced Assessment, the Measurements of Student Progress exam, and the High School Proficiency Exam.

Graduation Rate Data

These files provided us with the percent of students in a given public school that graduated on time (within four years), or graduated within five years, which we define as an extended rate.⁵⁷

Outcomes

Our main outcome of interest in our district and school variation analyses is the average number of instructional aides in districts or schools. In our analysis of student outcomes, we examine the following academic outcomes:

Proficiency Levels on Reading, Writing, and Math Assessments

We report school-level proficiency levels on state reading, writing, English language arts, and math assessments, as measured by the following state standardized tests:

- *The Measurements of Students Progress (MSP)*: The state standardized exam assessing reading, writing, math and science proficiency in grades 3-8 from school years 2009-10 to 2013-14. Since spring 2015, students have been administered the SBA instead of the MSP.⁵⁸

⁴⁹ OSPI duty code definitions.

⁵⁰ OSPI activity codes.

⁵¹ OSPI program codes.

⁵² OSPI—individuals assigned duty root 91 "Aides." Duty code definitions.

⁵³ OSPI—individuals assigned duty root 91 and activity code 27. No author. (2016) Accounting manual for public school districts in the state of Washington.

⁵⁴ OSPI—individuals assigned, duty roots 31–34. Duty code definitions.

⁵⁵ OSPI—individuals assigned, duty roots 11–13 and 21–25. Duty code definitions.

⁵⁶ OSPI—Individuals assigned, duty roots 41–49. Duty code definitions.

⁵⁷ See limitations for change in rate calculations and technical appendix for more information. No author. (2012) graduation rate calculations in Washington State.

- *The High School Proficiency Exam (HSPE)*: The state standardized exam assessing reading and writing proficiency in 10th grade from school years 2009-10 to 2013-14.⁵⁹ In part, the HSPE was used to determine students' graduation eligibility. Since the spring of 2015, students have been administered the SBA instead of the HSPE.
- *The Smarter Balanced Assessment (SBA)*: The current state standardized exam assessing English language arts (formerly reading and writing under the MSP and HSPE) and math in grades 3-8 and 11. SBA was rolled out in school year 2013-14 and fully implemented in 2014-15.⁶⁰

We report proficiency levels as the percent of students tested in a school *meeting* state standards. Students meeting state standards have scores that categorize their proficiency levels as either Level 3 (meets state proficiency) or Level 4 (exceeds state proficiency).⁶¹

On-Time and Extended Graduation Rates

We report school-level graduation rates as the percent of students in a school that graduate on time (within four years) and at an extended rate (within five years). We examine graduation rate data for school years 2010-11 to 2015-16 because OSPI changed how it calculated graduation rates during the 2009-10 school year and has used the same calculation since that time.

Statistical Analyses

For both of our district and school variation analyses and our outcome analysis, we use fixed effect estimation⁶² across school years 2009-10 to 2015-16.⁶³ While district, school, and year fixed effects and other covariates strengthen our models as best as possible,⁶⁴ without student-level data, we cannot determine true cause-and-effect relationships between instructional aides and district and school characteristics as well as relationships between instructional aides and students' academic outcomes.⁶⁵

The models we used to estimate our variation and outcome analyses are detailed below.

Variation Analysis Models: Use of Instructional Aides in Districts and Schools

In models 1 and 2, we estimate our main outcome of interest, the average number of instructional aide FTEs in a district or school,⁶⁶ as a function of student demographics (D), teacher characteristics (Q), school staffing units (X), school characteristics (Z), district (I) or school (s) fixed effects (s), year fixed effects (t), and an error term (e).

⁵⁸ Retrieved from <http://reportcard.ospi.k12.wa.us/AboutReportCard2006.aspx>.

⁵⁹ Ibid.

⁶⁰ Retrieved from <http://www.k12.wa.us/smarter/>.

⁶¹ Retrieved from <http://www.k12.wa.us/assessment/StateTesting/FAQ.aspx#14>.

⁶² Wooldridge, J.M. (2010). *Econometric analysis of cross section and panel data* (2nd ed.).

⁶³ Ordinary Least Squares (OLS) estimation using this panel data would result in omitted variable bias and would not control for time-invariant and statewide trends over time.

⁶⁴ Murnane, R.J., & Willett, J.B. (2011). *Methods matter: Improving causal inference in educational and social science research*. Oxford, New York: Oxford University Press.

⁶⁵ Casual effects could be estimated using school-level data through other types of experiments (e.g. a randomized control trial or instrumental variable analysis, which approximates random assignment). However, these experiments were not feasible during our project timeline.

⁶⁶ We use instructional aide FTE as our main dependent variable rather than instructional aide FTEs per 100 students because a school fixed effect model relies on variation within schools to estimate associations. Transforming instructional aide FTEs to instructional aide FTEs per 100 students reduces variation needed to run the model.

- 1) Average number of instructional aide FTEs in a district = $f(D, Q, X, l, t, e)$
- 2) Average number of instructional aide FTEs in a school = $f(D, Q, X, Z, s, t, e)$
 - *Student demographics in districts and schools (D)* includes total enrollment, the percent of male students, racial makeup, the percent of low-income students,⁶⁷ the percent of students enrolled in special education, and the percent of students enrolled in the Transitional Bilingual Instruction Program.⁶⁸
 - *Teacher characteristics (Q)* includes the percent of teachers with a master's degree, the average years of educational experience among teachers, and the average number of students per classroom teacher.
 - *School staffing levels (X)* includes school staffing controls for teachers, administrators, and "other" school staff (e.g., nurses and counselors), which we report as full-time equivalent units.
 - *School characteristics (Z)* includes an indicator for whether or not a school was piloted during the rollout of the Smarter Balanced Assessment during the 2013-14 school year.⁶⁹ We also control for schools that receive federal Title I funding.⁷⁰
 - *District fixed effects (l)* controls for unobserved and unique district-level characteristics that do not vary over time but may be correlated with instructional aide FTEs.
 - *School fixed effects (s)* controls for unobserved and unique school-level characteristics that do not vary over time but may be correlated with instructional aide FTEs.
 - *Year fixed effects (t)* controls for statewide trends affecting all districts and schools that could impact instructional aide FTEs.

Outcome Analysis Models: Instructional Aides and Student Academic Outcomes

In models 3 and 4, we estimate our two main outcomes of interest, 1) the percent of students meeting state standards and 2) graduating on time or at an extended rate, as a function of instructional aide FTEs in schools (A), student demographics (D), teacher characteristics and educator quality (Q), school staffing units (X), school characteristics (Z), school fixed effects (s), year fixed effects (y), and an error term (e).

- 3) Average % of tested students in a school meeting state standards = $f(A, D, Q, X, Z, s, t, e)$
- 4) Average % of students in a school graduating on time or at an extended rate = $f(A, D, Q, X, Z, s, t, e)$
 - *Instructional aide FTE (A)* is our main independent variable.⁷¹
 - *Student demographics (D)* includes total enrollment, the percent of male students, a school's racial makeup, the percent of low-income students,⁷² the percent of students enrolled in special

⁶⁷ Eligible for the free or reduced-price meal program.

⁶⁸ Enrolled in the state Transitional Bilingual Instructional Program.

⁶⁹ The transition from the MSP and HSPE to the SBA in 2013-14 resulted in some schools not receiving the MSP and HSPE and piloting the SBA instead. We control for this transition, which could have impacted proficiency levels among these schools.

⁷⁰ Title I funding may influence the amount of paraeducators in a given school and their quality as well as academic achievement—we account for this in our model.

⁷¹ We use instructional aide FTE as our main independent variable rather than instructional aide FTEs per 100 students because a school fixed effect model relies on variation within schools to predict the dependent variable. In this case, the dependent variables are proficiency levels and graduation rates. Transforming instructional aide FTEs to instructional aide FTEs per 100 students reduces variation needed to run the model.

⁷² Eligible for the free or reduced-priced meal program.

education, and the percent of students that are enrolled in the Transitional Bilingual Instruction Program.⁷³

- *Teacher characteristics (Q)* includes the percent of teachers in a school with a master's degree, the average years of educational experience among teachers, and the average number of students per classroom teacher.
- *School staffing levels (X)* includes school staffing controls for teachers, administrators, and other school staff like nurses and counselors, which we report as full-time equivalent units.
- *School characteristics (Z)* includes an indicator for whether or not a school was piloted during the rollout of the Smarter Balanced Assessment during the 2013-14 school year.⁷⁴ We also control for schools that receive federal Title I funding.⁷⁵
- *School fixed effects (s)* controls for unobserved and unique school-level characteristics (e.g., school culture) that do not vary over time but may be correlated with students' academic outcomes. While school fixed effects control for time-invariant characteristics within individual schools, it does not control for individual school characteristics that vary over our analysis period and also impact our outcomes of interest. To account for school-level characteristics that potentially change over time, we include student (*D*), teacher (*T*), staff (*X*), and school (*Z*) covariates described above.
- *Year fixed effects (t)* control for statewide trends affecting all schools that could impact achievement levels on exams and graduation rates during the period of analysis.

We tested for multicollinearity in both our variation and outcome analyses. High multicollinearity in a statistical model can increase the variance around variable coefficients, making it harder to determine a model's fit and interpret individual variables. In our district level variation analysis, we found that total enrollment, and school staffing levels (classroom teachers, educational staff associates, and administrative staff) were highly collinear. Therefore, we estimated several models, omitting these variables systematically in order to estimate associations between total enrollment and instructional aides and staffing levels and instructional aides separately. We tested individual models to determine collinearity (testing variation inflation factors) and found that once we removed either total enrollment or staffing levels, models were no longer highly collinear. We present results of our preferred model in the report, and the results of alternate models in Appendix III. We conducted multicollinearity tests for our school-level analysis and outcome analysis and found a reasonable amount of collinearity. Therefore we include all variables in models for these analyses.

Limitations

Our analyses have several limitations, which affect our ability to report causal results and limit interpretation of results.

School-Level Data

Ideally, to measure whether the variation in use of instructional aides across schools affects students' academic outcomes, we would want to observe instructional aides working directly with individual students or in individual classrooms. However, data available in the time frame to conduct this analysis precluded us from

⁷³ Enrolled in the state Transitional Bilingual Instructional Program.

⁷⁴ The transition from the MSP and HSPE to the SBA in 2013-14 resulted in some schools not receiving the MSP and HSPE and piloting the SBA instead. We control for this transition, which could have impacted proficiency levels among these schools.

⁷⁵ Title I funding may influence the amount of paraeducators in a given school and their quality as well as academic achievement, we account for this in our model.

analyzing student-level data. Instead, we used school-level data to estimate the association between district and school characteristics and instructional aide FTEs as well as the association between instructional aide FTEs and student outcomes. Further, we use fixed effect estimation rather than OLS estimation to account for time-invariant school characteristics and statewide trends over time.⁷⁶

While we adjusted our analysis as best as possible using district, school, and year fixed effects and relevant controls, school-level data and the fact that instructional aides and students are not randomly assigned to interact with one another precludes our ability to determine true causal relationships in either our variation or outcome analyses. For example, in our outcome analysis, any potential impact that instructional aides may have on student academic outcomes is aggregated with other factors that may also affect students' academic outcomes.⁷⁷ However, we cannot isolate these effects.

As a result, our findings describe associations rather than casual relationships.

Change in State Assessments over Time

In our outcome analysis, ideally, we would want to analyze assessment data over all school years, from 2009-10 through 2015-16. However, because standardized tests in Washington changed from the MSP and HSPE to the SBA in 2014-15, we had to analyze data in two separate time periods.

- *Across school years 2009-10 to 2013-14*, we examined the association between instructional aide FTEs and students' proficiency levels on reading, writing, and math assessments as measured by the MSP in grades 3-8 and the HSPE in grade 10.
- *Across school years 2014-15 to 2015-16*, we examined the association between instructional aide FTEs and students' proficiency levels on English language arts and math assessments as measured by the SBA in grades 3-8 and 11.

A trend analysis using fixed effects is most robust when employing data for all years available. However, we estimated the association between instructional aides and student outcomes over one five-year period (for MSP and HSPE exams) and estimated the association again over a shorter two-year period (for the SBA exam). Estimates drawn from the trend analysis using two years of assessment data are less robust and may not capture actual associations between instructional aides and student academic outcomes that may be present if additional years of data were available.⁷⁸

Generalizability of Results

Our analyses focus on public schools only. Additionally, we excluded public schools in which the highest grade levels were pre-kindergarten or kindergarten. Further, our definition of instructional aides may not capture all types of paraeducators working in classrooms. Instructional aides may also be assigned to other instruction-type activities as well (e.g., "learning resources" and "extracurricular" etc.), but the extent that instructional aides provide instructional support to students is unclear. In our analyses, we wanted to observe, as best as possible, aides directly providing instructional support to students. We determined this definition to be the most straightforward approach. As a result, our findings can only be generalized at district and school levels, for public schools only, and among instructional aides as we have defined them in this report.

⁷⁶ Wooldridge, J.M. (2010). *Econometric analysis of cross section and panel data* (2nd ed.).

⁷⁷ Murnane, R.J., & Willett, J.B. (2011). *Methods matter: Improving causal inference in educational and social science research*. Oxford, New York: Oxford University Press.

⁷⁸ We examined the association between instructional aide FTEs and the percent of students meeting state standards on math assessments across all years, as measured by both MSP and SBA assessments. However, results were significantly different in this full trend analysis, compared to separate analyses for each type of exam. Additionally, weighting methods between MSP, HSPE, and SBA exams preclude conducting our analysis using all years of data.

III. Use of Instructional Aide FTEs across Districts and Public Schools: Results

Using district, school, and year fixed effects, we estimated how student demographic, teacher characteristics and quality, and staffing levels are associated with instructional aide FTEs at district-and school-levels. We report our full results in [Exhibit A3](#). Since total enrollment and school staffing levels (educational staffing associates, teachers, and administrators) were collinear, we estimated separate fixed effects models, omitting each of the variables to examine associations with instructional aide FTEs.

Model 1 is our preferred model. At the district level, we find significant associations between student enrollment, the proportion of students in special education programs, and average class size (students per classroom teacher), and instructional aide FTEs.

Exhibit A3

District Characteristics Associated with Instructional Aide FTEs

Model 1 Total enrollment in district		Model 2 Educational staff associates		Model 3 Classroom teachers		Model 4 Administrative staff	
Total enrollment	0.014*** (0.00)	Educational staff associates (FTE)	0.33*** (0.11)	Classroom teachers (FTE)	0.24*** (0.04)	Administrators (FTE)	1.7*** (0.36)
% minority	0.10 (0.08)	% minority	0.01 (0.07)	% minority	0.07 (0.06)	% minority	0.03 (0.04)
% TBIP [^]	0.02 (0.05)	% TBIP [^]	0.02 (0.05)	% TBIP [^]	0.00 (0.04)	% TBIP [^]	-0.01 (0.04)
% special education	0.078** (0.04)	% special education	0.04 (0.04)	% special education	0.03 (0.04)	% special education	0.05 (0.03)
% FRPM [#]	0.00 (0.02)	% FRPM [#]	-0.05* (0.02)	% FRPM [#]	0.00 (0.01)	% FRPM [#]	-0.02 (0.01)
Students per classroom teacher	-0.49*** (0.18)	Students per classroom teacher	-0.05 (0.08)	Students per classroom teacher	0.04 (0.07)	Students per classroom teacher	-0.03 (0.06)
Average years of teaching	-0.02 (0.06)	Average years of teaching	-0.21 (0.13)	Average years of teaching	0.08 (0.06)	Average years of teaching	-0.02 (0.05)
% of teachers with master's degree	0.02 (0.02)	% of teachers with master's degree	0.04 (0.03)	% of teachers with master's degree	0.02* (0.01)	% of teachers with master's degree	0.02* (0.01)
Adjusted R ²	0.95	Adjusted R ²	0.91	Adjusted R ²	0.95	Adjusted R ²	0.95
No. of districts	292	No. of districts	292	No. of districts	292	No. of districts	292
No. of observations	2,028	No. of observations	2,028	No. of observations	2,028	No. of observations	2,028

Notes:

Standard error in parentheses.

* p-value < 0.10, ** p-value < 0.05, and *** p-value < 0.01.

[^] Transitional Bilingual Instruction Program.

[#] Free or reduced-price meals program.

Exhibit A4 shows results from our school-level analysis. At the school level, there is a significant association between the percent of students in the Transitional Bilingual Instruction Program, percent of students in special education programs, percent of students eligible for free or reduced-price meals, school staffing levels, and Title I, Part A funding with instructional aide FTEs. We did not estimate separate models because we found that variables were not highly collinear.

Exhibit A4

School Characteristics Associated with Instructional Aide FTEs

School variable	Change in instructional aide FTE
Total enrollment	0.00 (0.00)
% minority	0.01 (0.00)
% TBIP [^]	-0.03*** (0.01)
% special education	0.05*** (0.01)
% FRPM [#]	0.01*** (0.00)
Students per classroom teacher	0.01 (0.01)
Average years of teaching experience	0.01 (0.01)
% of teachers with master's degree	0.00 (0.00)
Educational staff associates (FTE)	0.06*** (0.01)
Classroom teachers (FTE)	0.14*** (0.01)
Administrators (FTE)	-0.13* (0.07)
Title I school	0.22** (0.08)
Adjusted R ²	0.75
No. of schools	1,830
No. of observations	12,191

Notes:

Standard error in parentheses.

* p-value < 0.10, ** p-value < 0.05, and *** p-value < 0.01.

[^] Transitional Bilingual Instruction Program.

[#] Free or reduced-price meals program.

IV. Instructional Aides and Student Academic Outcome Analysis: Results

Exhibit A5

Descriptives: Means and Standard Deviations for Assessment Analysis
(Smarter Balanced Assessment—Math)

Variable	Grade level						
	3	4	5	6	7	8	11
% met state math standard	56.70 (19.16)	53.02 (19.77)	46.37 (20.04)	45.01 (20.27)	45.63 (18.46)	43.23 (20.83)	19.80 (15.54)
Instructional aides (FTE)	5.61 (3.37)	5.57 (3.37)	5.52 (3.35)	5.05 (3.25)	4.85 (3.32)	4.89 (3.35)	5.64 (4.51)
% American Indian	1.83 (7.22)	1.81 (7.13)	1.85 (7.26)	2.48 (8.80)	2.87 (9.35)	2.77 (9.01)	3.29 (9.75)
% Asian	6.21 (9.08)	6.22 (9.04)	6.27 (9.00)	5.37 (7.56)	4.90 (7.55)	5.00 (7.62)	4.84 (7.28)
% Pacific Islander	0.96 (1.66)	0.96 (1.67)	0.98 (1.68)	0.89 (1.51)	0.77 (1.39)	0.78 (1.38)	0.64 (1.23)
% African American	4.21 (7.14)	4.23 (7.16)	4.27 (7.17)	3.46 (5.36)	3.14 (5.41)	3.12 (5.35)	3.23 (5.81)
% Hispanic	22.46 (20.58)	22.29 (20.44)	22.10 (20.30)	20.33 (19.35)	20.47 (20.30)	20.25 (19.88)	18.85 (18.86)
% two or more races	8.02 (4.93)	8.00 (4.92)	8.00 (4.87)	7.42 (4.94)	6.17 (4.47)	6.13 (4.40)	5.55 (4.00)
% male	51.60 (3.30)	51.65 (3.28)	51.59 (3.29)	51.46 (4.02)	51.16 (4.05)	51.24 (4.05)	51.53 (4.09)
% TBIP [^]	14.77 (16.10)	14.66 (15.99)	14.37 (15.83)	9.49 (12.75)	6.49 (8.95)	6.18 (8.30)	3.90 (5.37)
% special education	14.32 (5.24)	14.25 (5.24)	14.21 (5.21)	13.71 (4.69)	13.05 (4.43)	12.93 (4.31)	11.98 (4.00)
% FRPM [#]	50.02 (24.63)	49.99 (24.56)	49.78 (24.52)	48.53 (22.63)	47.81 (21.85)	47.33 (21.57)	42.92 (19.09)
Students per classroom teacher	15.51 (2.95)	15.51 (2.98)	15.53 (2.98)	15.61 (3.68)	15.51 (4.08)	15.65 (4.09)	16.22 (4.86)
Average years of teaching experience	13.17 (3.18)	13.16 (3.23)	13.18 (3.24)	13.86 (3.25)	14.32 (3.28)	14.35 (3.25)	14.64 (3.05)
% of teachers with master's degree	63.88 (12.08)	63.83 (12.15)	64.07 (12.16)	66.57 (12.18)	68.76 (11.91)	68.77 (11.68)	69.23 (11.51)
Educational staff associates (FTE)	2.63 (2.77)	2.63 (2.77)	2.64 (2.78)	2.63 (2.76)	2.65 (2.11)	2.75 (2.23)	3.46 (3.17)
Classroom teachers (FTE)	26.85 (12.51)	26.83 (12.57)	26.88 (12.54)	27.25 (13.96)	27.59 (15.02)	28.63 (16.54)	35.77 (25.99)
Administrators (FTE)	1.37 (0.75)	1.37 (0.75)	1.38 (0.75)	1.54 (0.86)	1.67 (0.91)	1.73 (0.97)	2.14 (1.46)
Total enrollment	445 (175)	444 (172)	447 (177)	485 (248)	508 (305)	548 (366)	870 (670)
Title 1 school	0.65 (0.48)	0.65 (0.48)	0.64 (0.48)	0.55 (0.50)	0.42 (0.49)	0.39 (0.49)	0.23 (0.42)
No. of schools	1,121	1,116	1,119	694	474	499	352
No. of observations	2,206	2,192	2,180	1,327	915	940	692

Notes:

Standard deviations in parentheses.

[^] Transitional Bilingual Instruction Program.

[#] Free or reduced-price meals program.

Exhibit A6

Descriptives: Means and Standard Deviations for Assessment Analysis (Smarter Balanced Assessment—ELA)

Variable	Grade level						
	3	4	5	6	7	8	11
% met state ELA standard	52.35 (19.48)	54.46 (19.66)	57.16 (19.31)	53.69 (20.08)	54.73 (18.57)	55.50 (20.70)	28.12 (21.10)
Instructional aides (FTE)	5.61 (3.37)	5.58 (3.37)	5.52 (3.35)	5.05 (3.25)	4.86 (3.32)	4.94 (3.40)	5.64 (4.51)
% American Indian	1.83 (7.23)	1.81 (7.13)	1.85 (7.26)	2.48 (8.80)	2.87 (9.36)	2.77 (9.01)	3.29 (9.75)
% Asian	6.21 (9.09)	6.22 (9.04)	6.26 (9.00)	5.36 (7.57)	4.90 (7.55)	5.02 (7.63)	4.84 (7.28)
% Pacific Islander	0.96 (1.66)	0.96 (1.67)	0.98 (1.68)	0.89 (1.51)	0.77 (1.39)	0.79 (1.42)	0.64 (1.23)
% African American	4.21 (7.15)	4.23 (7.16)	4.27 (7.17)	3.46 (5.36)	3.14 (5.41)	3.14 (5.37)	3.23 (5.81)
% Hispanic	22.46 (20.58)	22.28 (20.44)	22.13 (20.35)	20.32 (19.36)	20.46 (20.32)	20.25 (19.87)	18.85 (18.86)
% two or more races	8.02 (4.94)	8.00 (4.92)	8.00 (4.87)	7.41 (4.94)	6.15 (4.45)	6.15 (4.40)	5.55 (4.00)
% male	51.60 (3.31)	51.65 (3.28)	51.59 (3.29)	51.46 (4.02)	51.17 (4.01)	51.25 (4.05)	51.53 (4.09)
% TBIP [^]	14.77 (16.11)	14.65 (15.99)	14.40 (15.86)	9.49 (12.76)	6.50 (8.95)	6.19 (8.30)	3.90 (5.37)
% special education	14.32 (5.24)	14.25 (5.23)	14.22 (5.21)	13.71 (4.70)	13.07 (4.41)	12.92 (4.32)	11.98 (4.00)
% FRPM [#]	50.02 (24.63)	49.97 (24.57)	49.81 (24.52)	48.51 (22.67)	47.82 (21.84)	47.33 (21.61)	42.92 (19.09)
Students per classroom teacher	15.51 (2.95)	15.51 (2.98)	15.53 (2.98)	15.61 (3.68)	15.50 (4.07)	15.67 (4.11)	16.22 (4.86)
Average years of teaching experience	13.17 (3.18)	13.16 (3.23)	13.18 (3.24)	13.86 (3.25)	14.32 (3.29)	14.33 (3.25)	14.64 (3.05)
% of teachers with master's degree	63.88 (12.08)	63.83 (12.15)	64.06 (12.17)	66.57 (12.19)	68.72 (11.87)	68.80 (11.67)	69.23 (11.51)
Educational staff associates (FTE)	2.63 (2.77)	2.63 (2.77)	2.64 (2.78)	2.63 (2.76)	2.65 (2.11)	2.79 (2.27)	3.46 (3.17)
Classroom teachers (FTE)	26.85 (12.51)	26.82 (12.56)	26.89 (12.57)	27.24 (13.96)	27.62 (15.00)	28.80 (16.69)	35.77 (25.99)
Administrators (FTE)	1.37 (0.75)	1.37 (0.75)	1.38 (0.76)	1.54 (0.86)	1.67 (0.91)	1.74 (0.98)	2.14 (1.46)
Total enrollment	445 (175)	444 (172)	447 (177)	485 (248)	508 (304)	551 (371)	870 (670)
Title 1 school	0.65 (0.48)	0.65 (0.48)	0.64 (0.48)	0.55 (0.50)	0.42 (0.49)	0.39 (0.49)	0.23 (0.42)
No. of schools	1,121	1,116	1,118	694	473	500	351
No. of observations	2,206	2,192	2,179	1,328	914	941	689

Notes:

Standard deviations in parentheses.

[^] Transitional Bilingual Instruction Program.

[#] Free or reduced-price meals program.

Exhibit A7

Descriptives: Means and Standard Deviations for Assessment Analysis (Measurements of Student Progress—Math)

Variable	Grade level						
	3	4	5	6	7	8	10
% met state math standard	60.23 (20.89)	55.45 (21.45)	57.04 (21.19)	54.85 (22.28)	52.26 (22.30)	45.89 (21.72)	39.34 (17.18)
Instructional aides (FTE)	5.09 (2.93)	5.08 (2.93)	5.04 (2.90)	4.51 (2.76)	4.03 (2.66)	4.22 (2.91)	5.90 (4.45)
% American Indian	2.26 (7.69)	2.26 (7.70)	2.30 (7.77)	2.92 (9.32)	3.32 (10.00)	3.21 (9.64)	4.55 (12.14)
% Asian	6.58 (8.53)	6.60 (8.55)	6.67 (8.61)	5.74 (7.36)	4.82 (6.67)	4.87 (6.73)	5.70 (7.44)
% Pacific Islander	0.95 (1.59)	0.95 (1.59)	0.95 (1.59)	0.85 (1.46)	0.67 (1.26)	0.65 (1.25)	0.49 (1.13)
% African American	4.61 (7.41)	4.62 (7.43)	4.64 (7.43)	3.71 (5.52)	3.38 (5.73)	3.35 (5.70)	3.93 (6.67)
% Hispanic	19.34 (20.02)	19.27 (20.02)	19.09 (19.82)	17.18 (18.49)	17.72 (19.63)	17.61 (19.56)	13.71 (18.13)
% two or more races	4.91 (4.79)	4.90 (4.79)	4.90 (4.74)	4.76 (4.79)	3.97 (4.23)	3.91 (4.16)	0.00 (0.00)
% male	51.54 (3.32)	51.57 (3.26)	51.57 (3.15)	51.54 (3.33)	51.52 (3.63)	51.50 (3.50)	51.57 (3.31)
% TBIP [^]	11.93 (14.31)	11.84 (14.25)	11.62 (14.08)	7.72 (10.87)	5.20 (8.05)	4.96 (7.57)	3.42 (5.23)
% special education	14.32 (5.32)	14.30 (5.30)	14.21 (5.30)	13.37 (4.70)	12.43 (4.12)	12.30 (4.07)	10.55 (3.21)
% FRPM [#]	49.92 (24.65)	49.85 (24.65)	49.78 (24.54)	47.89 (23.05)	48.01 (21.97)	47.49 (21.74)	40.69 (19.90)
Students per classroom teacher	16.33 (3.48)	16.33 (3.49)	16.33 (3.44)	16.08 (3.85)	15.79 (4.65)	15.86 (4.65)	16.26 (4.47)
Average years of teaching experience	12.35 (2.76)	12.36 (2.76)	12.33 (2.76)	12.32 (2.74)	12.16 (2.91)	12.18 (2.88)	12.78 (2.30)
% of teachers with master's degree	65.49 (13.50)	65.38 (13.50)	65.53 (13.53)	66.41 (13.20)	66.82 (13.59)	66.67 (13.42)	66.52 (9.57)
Educational staff associates (FTE)	2.07 (2.41)	2.06 (2.42)	2.06 (2.41)	2.03 (1.56)	2.34 (1.78)	2.49 (1.94)	3.80 (2.93)
Classroom teachers (FTE)	23.11 (7.96)	23.06 (7.93)	23.23 (7.99)	24.99 (11.45)	26.50 (14.25)	28.04 (16.24)	42.67 (27.46)
Administrators (FTE)	1.05 (0.46)	1.05 (0.45)	1.07 (0.47)	1.32 (0.79)	1.66 (0.90)	1.74 (0.97)	2.42 (1.33)
Total enrollment	430 (164)	429 (163)	432 (164)	474 (238)	508 (305)	544 (356)	877 (626)
Title 1 school	0.62 (0.48)	0.62 (0.49)	0.61 (0.49)	0.48 (0.50)	0.33 (0.47)	0.30 (0.46)	0.20 (0.40)
No. of schools	1,085	1,075	1,083	717	456	458	325
No. of observations	4,214	4,190	4,156	2,660	1,731	1,718	1,352

Notes:

Standard deviations in parentheses.

[^] Transitional Bilingual Instruction Program.

[#] Free or reduced-price meals program.

Exhibit A8

Descriptives: Means and Standard Deviations for Assessment Analysis
(Measurements of Student Progress and High School Proficiency Exam—Reading)

Variable	Grade level						
	3	4	5	6	7	8	10*
% met state reading standard	68.77 (20.16)	66.48 (20.29)	67.08 (20.50)	65.47 (21.86)	59.06 (22.74)	61.65 (23.13)	77.98 (20.65)
Instructional aides (FTE)	5.07 (2.95)	5.05 (2.95)	5.02 (2.92)	4.49 (2.78)	4.02 (2.69)	4.21 (2.92)	5.86 (4.65)
% American Indian	2.22 (7.73)	51.57 (3.30)	2.26 (7.82)	2.91 (9.42)	3.27 (10.05)	3.17 (9.69)	3.47 (9.86)
% Asian	6.64 (8.64)	2.21 (7.67)	6.72 (8.71)	5.68 (7.41)	4.89 (6.88)	4.93 (6.91)	5.06 (7.21)
% Pacific Islander	0.95 (1.59)	6.65 (8.65)	0.95 (1.59)	0.84 (1.44)	0.69 (1.30)	0.67 (1.28)	0.55 (1.17)
% African American	4.66 (7.57)	0.95 (1.59)	4.68 (7.59)	3.63 (5.51)	3.39 (5.79)	3.35 (5.75)	3.48 (6.29)
% Hispanic	19.55 (19.93)	4.66 (7.59)	19.36 (19.78)	17.40 (18.58)	17.90 (19.62)	17.84 (19.63)	16.37 (18.56)
% two or more races	5.25 (4.84)	19.48 (19.92)	5.22 (4.78)	4.98 (4.82)	4.23 (4.31)	4.16 (4.23)	3.89 (4.20)
% male	51.54 (3.33)	5.23 (4.83)	51.56 (3.26)	51.54 (3.45)	51.52 (3.82)	51.51 (3.72)	51.52 (3.79)
% TBIP^	12.14 (14.39)	14.28 (5.31)	11.85 (14.17)	7.61 (10.76)	5.26 (8.08)	5.03 (7.55)	3.55 (5.44)
% special education	14.32 (5.32)	12.06 (14.34)	14.20 (5.30)	13.41 (4.75)	12.51 (4.22)	12.39 (4.18)	11.30 (3.91)
% FRPM#	50.08 (24.81)	50.01 (24.82)	49.97 (24.71)	48.08 (23.13)	48.22 (22.18)	47.70 (22.02)	43.49 (20.47)
Students per classroom teacher	16.25 (3.42)	16.24 (3.45)	16.24 (3.41)	16.01 (3.86)	15.73 (4.61)	15.82 (4.61)	15.91 (5.10)
Average years of teaching experience	12.54 (2.87)	12.56 (2.90)	12.52 (2.90)	12.56 (2.87)	12.45 (3.09)	12.50 (3.08)	13.08 (2.82)
% of teachers with master's degree	65.42 (13.40)	65.33 (13.35)	65.47 (13.40)	66.54 (13.16)	67.05 (13.50)	66.90 (13.30)	66.89 (12.16)
Educational staff associates (FTE)	2.09 (2.51)	2.08 (2.52)	2.09 (2.52)	2.05 (1.60)	2.35 (1.80)	2.50 (1.94)	3.73 (3.02)
Classroom teachers (FTE)	23.12 (8.01)	23.07 (8.01)	23.25 (8.07)	25.00 (11.71)	26.46 (14.26)	28.05 (16.32)	41.19 (27.68)
Administrators (FTE)	1.06 (0.46)	1.06 (0.45)	1.07 (0.47)	1.34 (0.80)	1.66 (0.90)	1.75 (0.98)	2.40 (1.43)
Total enrollment	428 (164)	428 (164)	431 (165)	473 (243)	506 (304)	544 (359)	855 (639)
Title 1 school	0.63 (0.48)	0.62 (0.48)	0.61 (0.49)	0.48 (0.50)	0.33 (0.47)	0.31 (0.46)	0.18 (0.39)
No. of schools	1,096	1,086	1,097	733	472	491	360
No. of observations	4,882	4,859	4,823	3,040	2,032	2,035	1,677

Notes:

Standard deviations in parentheses.

* Reading assessed in 10th grade using the High School Proficiency Exam (HSPE).

^ Transitional Bilingual Instruction Program.

Free or reduced-price meals program.

Exhibit A9

Descriptives: Means and Standard Deviations for Assessment Analysis
(Measurements of Student Progress and High School Proficiency Exam—Writing)

Variable	Grade level		
	4	7	10*
% met state writing standard	58.45 (20.82)	64.12 (23.45)	81.97 (20.60)
Instructional aides (FTE)	5.05 (2.95)	4.02 (2.69)	5.86 (4.65)
% American Indian	2.21 (7.67)	3.27 (10.04)	3.47 (9.86)
% Asian	6.65 (8.65)	4.89 (6.88)	5.06 (7.21)
% Pacific Islander	0.95 (1.59)	0.69 (1.30)	0.55 (1.17)
% African American	4.66 (7.59)	3.39 (5.79)	3.48 (6.29)
% Hispanic	19.48 (19.92)	17.91 (19.62)	16.37 (18.56)
% two or more races	5.23 (4.83)	4.23 (4.30)	3.89 (4.20)
% male	51.57 (3.30)	51.51 (3.82)	51.52 (3.79)
% TBIP [^]	12.06 (14.34)	5.26 (8.08)	3.55 (5.44)
% special education	14.28 (5.31)	12.51 (4.22)	11.30 (3.91)
% FRPM [#]	50.01 (24.82)	48.24 (22.18)	43.49 (20.47)
Students per classroom teacher	16.24 (3.45)	15.73 (4.61)	15.91 (5.10)
Average years of teaching experience	12.56 (2.90)	12.45 (3.09)	13.08 (2.82)
% of teachers with master's degree	65.33 (13.35)	67.05 (13.50)	66.89 (12.16)
Educational staff associates (FTE)	2.08 (2.52)	2.35 (1.80)	3.73 (3.02)
Classroom teachers (FTE)	23.07 (8.01)	26.45 (14.26)	41.19 (27.68)
Administrators (FTE)	1.06 (0.45)	1.66 (0.90)	2.40 (1.43)
Total enrollment	428 (164)	506 (304)	855 (639)
Title 1 school	0.62 (0.48)	0.33 (0.47)	0.18 (0.39)
No. of schools	1,086	471	358
No. of observations	4,858	2,030	1,675

Notes:

Standard deviations in parentheses.

* Writing assessed in 10th grade using the High School Proficiency Exam (HSPE).

[^] Transitional Bilingual Instruction Program.

[#] Free or reduced-price meals program.

Exhibit A10

Results: Math Assessment Results
(Smarter Balanced Assessment, School Years 2014-15 to 2015-16)

Variable	Grade level						
	3	4	5	6	7	8	11
Instructional aides (FTE)	0.10 (0.11)	0.13 (0.10)	-0.13 (0.10)	0.19 (0.14)	-0.09 (0.15)	-0.03 (0.17)	-0.06 (0.23)
% American Indian	0.83 (1.06)	0.55 (0.81)	-0.94 (0.68)	1.59 (1.03)	-0.99 (0.80)	-0.41 (1.03)	1.61** (0.70)
% Asian	-0.26 (0.35)	-0.75** (0.32)	-0.55* (0.31)	-0.53 (0.53)	-0.63 (0.44)	0.62 (0.47)	0.07 (1.21)
% Pacific Islander	0.48 (0.76)	-1.14 (0.70)	-1.12 (0.74)	-2.39** (1.04)	0.25 (1.16)	-0.03 (1.24)	0.60 (2.60)
% African American	-1.28 (0.80)	-0.81 (0.52)	-0.74 (0.54)	-1.45 (0.95)	-0.54 (0.62)	-0.10 (0.92)	-1.57* (0.90)
% Hispanic	0.23 (0.20)	-0.26 (0.20)	0.12 (0.16)	-0.44 (0.36)	-0.26 (0.34)	0.38 (0.42)	0.35 (0.48)
% two or more races	0.22 (0.41)	-0.23 (0.34)	-0.17 (0.35)	-1.07 (0.79)	-0.96 (0.74)	-0.69 (0.76)	-0.58 (0.86)
% male	-0.17 (0.31)	-0.08 (0.26)	-0.06 (0.25)	0.83* (0.48)	0.36 (0.54)	-0.47 (0.33)	-0.21 (0.34)
% TBIP [^]	-0.19 (0.18)	0.11 (0.17)	0.19 (0.19)	0.38 (0.34)	-0.01 (0.31)	-0.06 (0.30)	-0.65 (0.60)
% special education	0.21 (0.30)	0.24 (0.23)	-0.05 (0.25)	-0.47 (0.45)	-0.51 (0.46)	0.32 (0.35)	-0.07 (0.37)
% FRPM [#]	-0.10 (0.11)	-0.05 (0.10)	-0.14 (0.11)	0.00 (0.14)	0.03 (0.14)	-0.15 (0.13)	0.11 (0.14)
Students per classroom teacher	0.33 (0.30)	-0.19 (0.37)	0.08 (0.25)	-0.27 (0.48)	0.45 (0.38)	0.34 (0.46)	-0.15 (0.38)
Average years of teaching experience	0.14 (0.30)	-0.27 (0.36)	0.65** (0.32)	-0.45 (0.60)	0.32 (0.61)	-0.90 (0.82)	0.52 (0.74)
% of teachers with master's degree	0.01 (0.06)	0.09 (0.10)	-0.03 (0.07)	-0.10 (0.13)	0.06 (0.13)	0.15 (0.17)	-0.16 (0.12)
Educational staff associates (FTE)	-0.01 (0.11)	0.01 (0.08)	0.18** (0.07)	-0.29 (0.35)	-0.22 (0.35)	0.22 (0.48)	0.48 (0.40)
Classroom teachers (FTE)	-0.06 (0.05)	-0.02 (0.04)	0.06 (0.04)	0.00 (0.06)	0.02 (0.07)	-0.13 (0.14)	-0.14 (0.09)
Administrators (FTE)	0.56 (0.78)	0.61 (0.71)	-0.48 (0.68)	-0.17 (0.87)	0.71 (0.88)	1.16 (1.18)	-0.49 (1.09)
Total enrollment	0.00 (0.01)	0.00 (0.01)	0.00 (0.01)	0.02 (0.02)	0.00 (0.01)	-0.01 (0.01)	-0.03* (0.02)
Title 1 school	0.10 (1.51)	-0.23 (1.46)	-1.62 (1.54)	1.97 (1.78)	-1.09 (1.57)	-0.73 (1.98)	-2.16 (3.23)
Adjusted R ²	0.72	0.77	0.79	0.74	0.76	0.78	0.6
No. of schools ⁺	1,121	1,116	1,119	694	474	499	352
No. of observations	2,206	2,192	2,180	1,327	915	940	692

Notes:

Robust standard errors in parentheses.

* p-value < 0.10, ** p-value < 0.05, and *** p-value < 0.01.

[^] Transitional Bilingual Instruction Program.

[#] Free or reduced-price meals program.

⁺ Field schools omitted from model because collinearity.

Exhibit A11

Results: English Language Arts Assessment Results (Smarter Balanced Assessment, School Years 2014-15 to 2015-16)

Variable	Grade level						
	3	4	5	6	7	8	11
Instructional aides (FTE)	0.10 (0.11)	0.09 (0.11)	-0.09 (0.09)	0.13 (0.13)	0.04 (0.16)	-0.27 ⁺ (0.16)	-0.09 (0.41)
% American Indian	0.27 (0.73)	1.64 (1.03)	-1.11 (0.70)	0.36 (0.95)	-1.61 ⁺ (0.97)	-1.05 (1.18)	1.24 (1.61)
% Asian	-0.02 (0.27)	-0.33 (0.34)	-0.61 ^{**} (0.29)	-0.28 (0.51)	-0.44 (0.44)	0.73 (0.54)	2.45 (1.98)
% Pacific Islander	0.78 (0.72)	0.36 (0.70)	-1.18 ⁺ (0.64)	-1.51 (1.08)	-1.52 (1.21)	-0.56 (1.47)	11.49 ^{**} (4.62)
% African American	-0.13 (0.38)	-0.85 (0.68)	-0.75 (0.50)	-1.52 (0.94)	-0.18 (0.71)	-1.06 (0.91)	-4.12 ^{**} (1.96)
% Hispanic	0.35 ⁺ (0.20)	-0.02 (0.20)	0.09 (0.18)	0.08 (0.42)	0.15 (0.35)	0.07 (0.46)	-0.24 (1.09)
% two or more races	1.01 ^{***} (0.37)	0.64 (0.43)	-0.15 (0.34)	0.09 (0.51)	-0.79 (0.77)	-0.28 (0.84)	0.04 (1.48)
% male	0.00 (0.24)	-0.43 (0.37)	-0.09 (0.27)	0.20 (0.28)	0.10 (0.57)	-0.57 (0.35)	-0.02 (0.56)
% TBIP [^]	-0.24 (0.18)	0.05 (0.17)	-0.14 (0.16)	0.37 (0.34)	-0.28 (0.33)	-0.26 (0.37)	-1.03 (0.87)
% special education	0.18 (0.26)	-0.34 (0.28)	0.15 (0.23)	-0.39 (0.34)	0.03 (0.46)	0.42 (0.46)	0.05 (0.65)
% FRPM [#]	-0.11 (0.11)	-0.04 (0.15)	0.05 (0.11)	-0.19 (0.12)	-0.03 (0.14)	-0.10 (0.15)	-0.02 (0.24)
Students per classroom teacher	-0.15 (0.34)	-0.06 (0.28)	-0.05 (0.31)	0.32 (0.38)	0.35 (0.47)	0.28 (0.46)	-0.24 (0.74)
Average years of teaching experience	0.34 (0.32)	-0.22 (0.40)	0.38 (0.41)	-0.29 (0.52)	0.76 (0.73)	-0.61 (0.89)	2.20 [*] (1.32)
% of teachers with master's degree	-0.01 (0.06)	0.04 (0.10)	-0.02 (0.09)	0.01 (0.10)	0.00 (0.15)	0.10 (0.18)	-0.45 ⁺ (0.25)
Educational staff associates (FTE)	-0.01 (0.11)	-0.14 ^{**} (0.06)	0.17 ^{***} (0.06)	-0.20 (0.33)	-0.48 (0.38)	0.47 (0.47)	0.18 (0.65)
Classroom teachers (FTE)	0.01 (0.05)	-0.08 [*] (0.04)	0.09 ^{**} (0.04)	0.01 (0.06)	0.01 (0.07)	-0.16 (0.14)	-0.37 ^{**} (0.15)
Administrators (FTE)	0.12 (0.73)	1.12 ⁺ (0.67)	-0.73 (0.61)	0.75 (0.93)	1.09 (0.93)	0.56 (1.16)	2.27 (1.93)
Total enrollment	0.01 (0.01)	-0.01 (0.01)	0.01 (0.01)	0.02 (0.02)	0.00 (0.01)	-0.01 (0.01)	-0.03 (0.03)
Title 1 school	0.63 (1.52)	0.25 (1.84)	1.31 (1.32)	0.53 (1.94)	1.59 (1.76)	1.62 (2.33)	10.07 ^{**} (4.79)
Adjusted R ²	0.75	0.77	0.79	0.77	0.71	0.76	0.27
No. of schools ⁺	1,121	1,116	1,118	694	473	500	351
No. of observations	2,206	2,192	2,179	1,328	914	941	689

Notes:

Robust standard errors in parentheses.

* p-value < 0.10, ** p-value < 0.05, and *** p-value < 0.01.

[^] Transitional Bilingual Instruction Program.

[#] Free or reduced-price meals program.

⁺ Field schools omitted from model because collinearity.

Exhibit A12

Results: Math Assessment Results
(Measurements of Student Progress, School Years 2009-10 to 2013-14)

Variable	Grade level						
	3	4	5	6	7	8	10
Instructional aides (FTE)	0.35 [*] (0.19)	-0.05 (0.19)	0.18 (0.19)	0.25 (0.22)	-0.31 (0.25)	-0.09 (0.26)	0.10 (0.22)
% American Indian	0.05 (0.11)	0.22 [*] (0.13)	0.01 (0.10)	-0.28 ^{***} (0.10)	-0.15 (0.09)	-0.08 (0.08)	-0.12 (0.08)
% Asian	0.02 (0.12)	0.01 (0.13)	-0.12 (0.12)	0.01 (0.16)	-0.09 (0.21)	-0.08 (0.22)	0.57 ^{***} (0.13)
% Pacific Islander	0.33 (0.29)	-0.38 (0.30)	-0.04 (0.30)	0.20 (0.37)	-0.72 [*] (0.41)	-0.75 [*] (0.39)	-1.19 (0.96)
% African American	-0.37 ^{***} (0.14)	-0.46 ^{***} (0.15)	-0.48 ^{***} (0.17)	-0.58 ^{***} (0.19)	-0.37 [*] (0.22)	-0.31 (0.19)	-0.78 ^{***} (0.18)
% Hispanic	0.00 (0.09)	-0.13 (0.09)	-0.13 (0.09)	-0.23 ^{**} (0.11)	-0.44 ^{***} (0.15)	-0.34 ^{**} (0.15)	-0.16 (0.10)
% two or more races ^{^^}	-0.16 ^{**} (0.08)	-0.32 ^{***} (0.10)	-0.16 [*] (0.09)	-0.24 ^{**} (0.11)	-0.35 ^{**} (0.14)	0.00 (0.14)	- (-)
% male	0.05 (0.11)	-0.04 (0.10)	-0.13 (0.10)	-0.01 (0.12)	-0.03 (0.13)	0.06 (0.15)	-0.58 ^{**} (0.26)
% TBIP [^]	-0.16 [*] (0.09)	0.01 (0.09)	-0.07 (0.10)	-0.09 (0.09)	-0.08 (0.12)	-0.16 (0.10)	0.52 [*] (0.29)
% special education	0.01 (0.09)	-0.22 ^{**} (0.09)	-0.06 (0.09)	-0.03 (0.12)	-0.17 (0.13)	-0.12 (0.13)	-0.46 (0.29)
% FRPM [#]	-0.05 (0.08)	-0.13 ^{**} (0.06)	0.03 (0.06)	0.04 (0.06)	-0.06 (0.09)	0.05 (0.07)	-0.41 ^{***} (0.09)
Students per classroom teacher	0.08 (0.23)	0.08 (0.19)	-0.19 (0.20)	0.07 (0.20)	-0.24 (0.20)	-0.54 ^{***} (0.14)	0.99 ^{**} (0.41)
Average years of teaching experience	0.00 (0.19)	-0.12 (0.22)	0.15 (0.18)	-0.32 (0.25)	0.08 (0.32)	0.13 (0.28)	-0.11 (0.38)
% of teachers with master's degree	-0.01 (0.03)	0.05 (0.03)	0.04 (0.03)	-0.03 (0.04)	-0.01 (0.05)	0.00 (0.05)	-0.05 (0.09)
Educational staff associates (FTE)	-0.37 ^{**} (0.22)	-0.08 (0.24)	-0.05 (0.23)	-0.43 (0.31)	0.40 (0.36)	0.28 (0.39)	-0.22 (0.37)
Classroom teachers (FTE)	0.16 (0.13)	0.37 ^{***} (0.13)	0.23 [*] (0.13)	0.03 (0.14)	0.09 (0.16)	0.21 (0.15)	0.34 [*] (0.17)
Administrators (FTE)	1.18 (0.88)	-0.22 (0.83)	1.75 ^{**} (0.83)	0.35 (0.75)	2.80 ^{***} (1.07)	0.35 (0.92)	-1.13 (0.79)
Total enrollment	-0.01 (0.01)	-0.01 (0.01)	0.00 (0.01)	0.00 (0.01)	-0.01 (0.01)	0.00 (0.01)	-0.01 [*] (0.01)
Title 1 school	-0.41 (0.95)	1.73 [*] (1.00)	0.51 (0.96)	2.45 [*] (1.41)	1.77 (1.46)	2.29 [*] (1.32)	0.38 (2.89)
Adjusted R ²	0.75	0.75	0.77	0.82	0.79	0.81	0.53
No. of schools ⁺	1,085	1,075	1,083	717	456	458	325
No. of observations	4,214	4,190	4,156	2,660	1,731	1,718	1,352

Notes:

Robust standard errors in parentheses.

* p-value < 0.10, ** p-value < 0.05, and *** p-value < 0.01.

^{^^} Omitted from model in 10th grade because of collinearity.

[^] Transitional Bilingual Instruction Program.

[#] Free or reduced-priced meals program.

⁺ Field schools omitted from model because collinearity.

Exhibit A13

Results: Reading Assessment Results

(Measurements of Student Progress and High School Proficiency Exam, School Years 2009-10 to 2013-14)

Variable	Grade level						
	3	4	5	6	7	8	10 ^{^^}
Instructional aides (FTE)	0.32** (0.15)	-0.14 (0.16)	0.28* (0.16)	0.10 (0.25)	-0.09 (0.25)	-0.45 (0.30)	0.31** (0.16)
% American Indian	0.04 (0.13)	0.09 (0.13)	-0.06 (0.09)	0.10 (0.17)	-0.12 (0.12)	-0.21* (0.13)	-0.40 (0.26)
% Asian	-0.09 (0.12)	-0.10 (0.12)	-0.04 (0.13)	-0.23 (0.20)	-0.15 (0.25)	-0.47* (0.28)	-0.56 (0.42)
% Pacific Islander	0.18 (0.30)	-0.37 (0.32)	-0.64** (0.29)	-0.35 (0.59)	-0.68 (0.66)	-1.57* (0.83)	-1.65** (0.68)
% African American	-0.16 (0.14)	-0.30** (0.13)	-0.14 (0.13)	-0.14 (0.17)	-0.44** (0.23)	-0.11 (0.19)	-0.35 (0.47)
% Hispanic	-0.14 (0.10)	-0.12 (0.09)	-0.12 (0.10)	-0.21 (0.15)	-0.47** (0.19)	-0.39* (0.21)	-0.22 (0.32)
% two or more races	-0.22** (0.97)	-0.21** (0.09)	-0.26** (0.08)	-0.21* (0.12)	-0.31** (0.15)	-0.32* (0.18)	-0.42 (0.27)
% male	-0.01 (0.14)	-0.05 (0.15)	-0.11 (0.16)	-0.26 (0.19)	-0.27 (0.19)	-0.11 (0.24)	-0.20 (0.31)
% TBIP [^]	-0.18** (0.09)	-0.25*** (0.07)	-0.35*** (0.10)	-0.17 (0.12)	-0.37*** (0.13)	-0.55*** (0.16)	0.01 (0.30)
% special education	-0.03 (0.12)	-0.13 (0.10)	-0.16* (0.09)	-0.04 (0.15)	-0.33* (0.20)	0.01 (0.23)	0.32 (0.36)
% FRPM [#]	0.08 (0.08)	-0.04 (0.08)	0.09 (0.07)	0.04 (0.08)	-0.09 (0.08)	0.07 (0.08)	0.11 (0.11)
Students per classroom teacher	-0.07 (0.16)	0.07 (0.64)	-0.37* (0.19)	0.22 (0.23)	-0.07 (0.23)	0.20 (0.22)	0.54** (0.23)
Average years of teaching experience	0.36 (0.24)	0.18 (0.27)	0.41* (0.22)	-0.45 (0.35)	-0.26 (0.43)	-0.49 (0.47)	-0.48 (0.38)
% of teachers with master's degree	0.05 (0.03)	0.05 (0.03)	0.05 (0.03)	-0.08 (0.05)	0.00 (0.06)	-0.09 (0.06)	-0.11* (0.06)
Educational staff associates (FTE)	-0.24 (0.19)	-0.46** (0.19)	-0.24 (0.20)	-0.66** (0.33)	0.27 (0.34)	0.40 (0.35)	-0.05 (0.26)
Classroom teachers (FTE)	0.14 (0.11)	0.28** (0.11)	0.19 (0.12)	0.17 (0.13)	0.07 (0.14)	0.03 (0.14)	0.08 (0.11)
Administrators (FTE)	-0.13 (0.90)	-1.14 (0.79)	0.91 (0.88)	1.31 (0.85)	3.20*** (1.02)	1.71* (1.01)	0.95 (0.67)
Total enrollment	-0.01* (0.01)	-0.01* (0.01)	0.00 (0.01)	-0.01** (0.01)	0.00 (0.01)	0.00 (0.01)	0.00 (0.01)
Title 1 school	0.74 (0.87)	1.32 (0.98)	0.65 (1.00)	2.71* (1.51)	1.50 (1.70)	3.70* (1.96)	1.31 (3.41)
Adjusted R ²	0.70	0.70	0.72	0.72	0.72	0.72	0.67
No. of schools ⁺	1,096	1,086	1,097	733	472	491	360
No. of observations	4,882	4,859	4,823	3,040	2,032	2,035	1,677

Notes:

Robust standard errors in parentheses.

* p-value < 0.10, ** p-value < 0.05, and *** p-value < 0.01.

^{^^} Reading assessed in 10th grade using the High School Proficiency Exam (HSPE).

[^] Transitional Bilingual Instruction Program.

[#] Free or reduced-price meals program.

⁺ Field schools omitted from model because collinearity.

Exhibit A14

Results: Writing Assessment Results

(Measurements of Student Progress and High School Proficiency Exam, School Years 2009-10 to 2013-14)

Variable	Grade level		
	4	7	10 ^{^^}
Instructional aides (FTE)	-0.06 (0.17)	-0.17 (0.27)	0.27 [*] (0.16)
% American Indian	0.18 (0.01)	-0.34 ^{***} (0.09)	-0.26 (0.28)
% Asian	-0.004 (0.12)	-0.30 (0.26)	-0.28 (0.48)
% Pacific Islander	0.047 (0.28)	0.10 (0.49)	-1.32 (0.83)
% African American	-0.022 (0.13)	-0.24 (0.19)	-0.06 (0.50)
% Hispanic	-0.05 (0.09)	-0.43 ^{**} (0.20)	-0.05 (0.35)
% two or more races	-0.16 [*] (0.09)	-0.29 ^{**} (0.16)	-0.37 (0.29)
% male	-0.18 (0.12)	-0.46 ^{***} (0.17)	-0.11 (0.32)
% TBIP [^]	-0.18 ^{**} (0.08)	-0.07 (0.16)	-0.02 (0.36)
% special education	-0.12 (0.09)	-0.25 (0.19)	0.42 (0.39)
% FRPM [#]	-0.09 (0.07)	-0.06 (0.08)	0.01 (0.12)
Students per classroom teacher	0.11 (0.18)	0.29 (0.23)	0.44 [*] (0.24)
Average years of teaching experience	-0.04 (0.25)	-0.22 (0.49)	-0.58 (0.43)
% of teachers with master's degree	0.05 (0.04)	-0.10 [*] (0.06)	-0.10 (0.06)
Educational staff associates (FTE)	-0.35 (0.22)	0.12 (0.45)	-0.02 (0.28)
Classroom teachers (FTE)	0.29 ^{**} (0.12)	0.38 ^{**} (0.17)	0.02 (0.12)
Administrators (FTE)	-1.21 (0.78)	2.14 ^{**} (1.06)	0.71 (0.73)
Total enrollment	0.00 (0.01)	-0.01 ^{**} (0.01)	0.00 (0.01)
Title 1 school	0.317 (1.00)	3.48 [*] (2.03)	0.79 (3.55)
Adjusted R ²	0.68	0.69	0.62
No. of schools ⁺	1,086	471	358
No. of observations	4,858	2,030	1,675

Notes:

Robust standard errors in parentheses.

* p-value < 0.10, ** p-value < 0.05, and *** p-value < 0.01.

^{^^} Writing assessed in 10th grade using the High School Proficiency Exam (HSPE).

[^] Transitional Bilingual Instruction Program.

[#] Free or reduced-price meals program.

⁺ Field schools omitted from model because collinearity.

Exhibit A15

Descriptives: Means and Standard Deviations for Graduation Analysis

Variable	Mean	Standard deviation	No. of observations
Instructional aides (FTEs)	6.11	4.96	1,830
On-time graduation rate	69.43	27.34	3,280
Extended graduation rate	72.25	26.67	3,418
Total enrollment	844	643	1,830
% American Indian	2.96	9.04	1,830
% Asian	5.11	7.48	1,830
% Pacific Islander	0.62	1.26	1,830
% African American	3.42	6.39	1,830
% Hispanic	18.38	19.58	1,830
% two or more races	5.33	4.36	1,830
% male	51.53	4.09	1,830
% TBIP [^]	4.62	7.13	1,830
% special education	11.79	4.66	1,830
% FRPM [#]	43.85	20.95	1,830
Students per classroom teacher	15.95	4.94	1,824
Average years of teaching experience	13.51	3.05	1,830
% of teachers with master's degree	67.18	12.14	1,823
Educational staff associates (FTE)	4.00	3.21	1,830
Classroom teachers (FTE)	42.93	28.67	1,830
Administrators (FTE)	2.53	1.48	1,830
Title I school	0.58	0.49	1,830

Notes:[^] Transitional Bilingual Instruction Program.[#] Free or reduced-price meals program.

Exhibit A16

Results: Graduation Rate Analysis (On-Time and Extended Rates)

Variable	On-time rate	Extended rate
Instructional aides (FTE)	0.00 (0.14)	-0.10 (0.11)
% American Indian	0.00 (0.21)	-0.25 (0.19)
% Asian	0.14 (0.31)	0.17 (0.21)
% Pacific Islander	0.74 (0.79)	0.33 (0.62)
% African American	-0.36 (0.29)	-0.26 (0.29)
% Hispanic	-0.06 (0.15)	0.21 (0.14)
% two or more races	0.19 (0.21)	-0.06 (0.17)
% male	0.13 (0.13)	-0.04 (0.11)
% TBIP [^]	-0.33** (0.15)	-0.17 (0.19)
% special education	-0.09 (0.15)	0.01 (0.14)
% FRPM [#]	-0.04 (0.06)	0.00 (0.06)
Students per classroom teacher	-0.01 (0.16)	0.03 (0.12)
Average years of teaching experience	0.14 (0.20)	-0.13 (0.15)
% of teachers with master's degree	0.02 (0.03)	-0.05** (0.03)
Educational staff associates (FTE)	0.29 (0.20)	0.34** (0.15)
Classroom teachers (FTE)	0.01 (0.05)	-0.03 (0.05)
Administrators (FTE)	0.09 (0.39)	0.27 (0.39)
Total enrollment	0.00 (0.003)	0.00 (0.003)
Title 1 school	3.37* (1.73)	2.65** (1.08)
Adjusted R ²	0.60	0.66
No. of schools	326	323
No. of observations	1,585	1,583

Notes:

Robust standard errors in parentheses.

* p-value < 0.10, ** p-value < 0.05, and *** p-value < 0.01.

[^] Transitional Bilingual Instruction Program.

[#] Free or reduced-price meals program.

V. Literature Review Citations

Studies Included in Meta-Analyses

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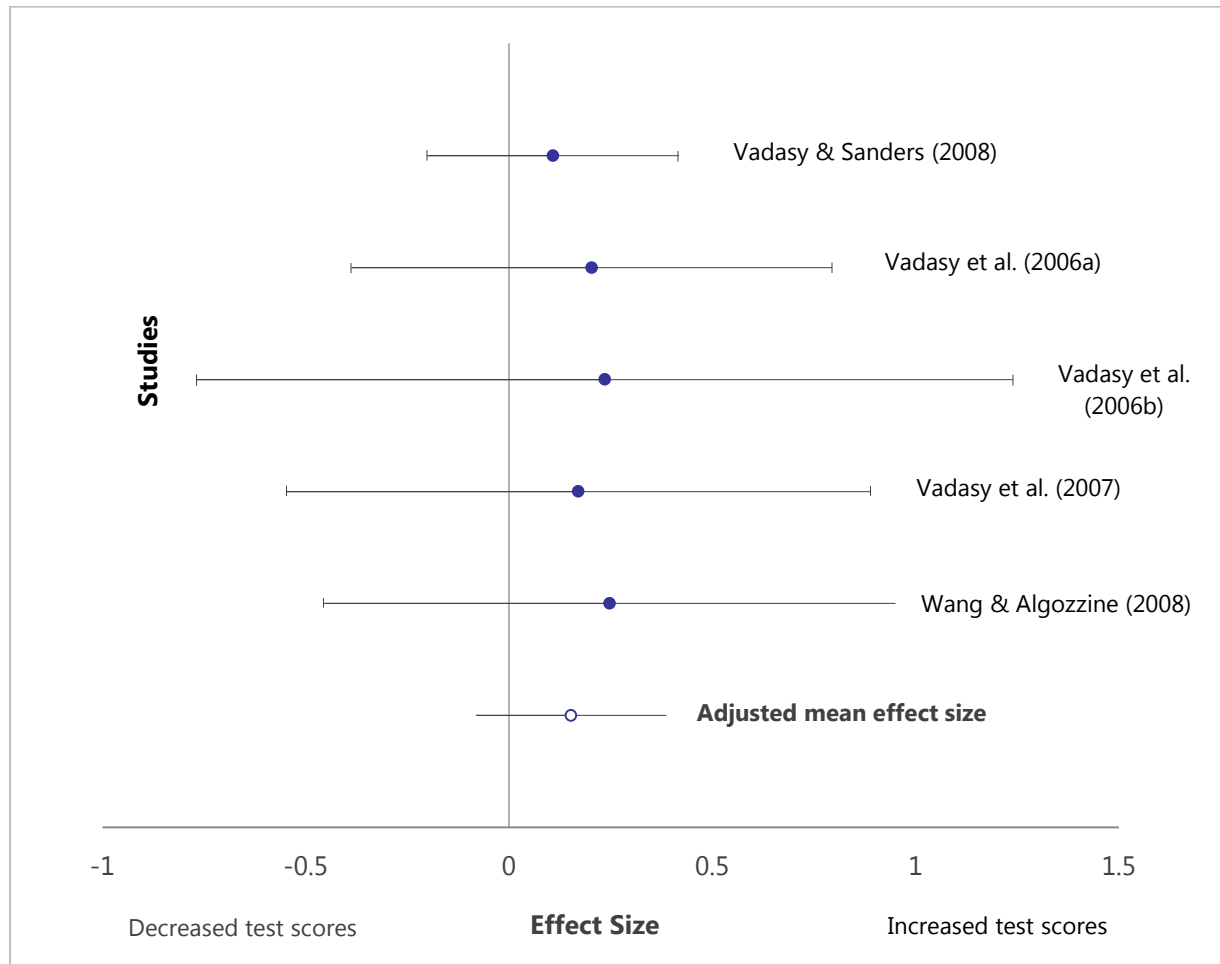
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VI. Meta-Analysis Forest Plot

Exhibit A17

Meta-Analytic Findings for Paraeducator-Delivered Supplemental Reading Interventions for At-Risk Students



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