NATIONAL CENTER *for* ANALYSIS *of* LONGITUDINAL DATA *in* EDUCATION RESEARCH

TRACKING EVERY STUDENT'S LEARNING EVERY YEAR

A program of research by the American Institutes for Research with Duke University, Northwestern University, Stanford University, University of Missouri-Columbia, University of North Carolina at Chapel Hill, University of Texas at Dallas, and University of Washington

The Effects of Middle School Remediation on Postsecondary Success: Regression Discontinuity Evidence from Florida

Umut Özek

WORKING PAPER No. 258-0921 • September 2021

The Effects of Middle School Remediation on Postsecondary Success: Regression Discontinuity Evidence from Florida

Umut Özek
American Institutes for Research/CALDER

Contents

Acknowledgments

I thank the anonymous school district for providing the data used in the analysis, and for providing useful feedback. I also thank Dan Goldhaber, Stephanie Cellini, Ben Backes, James Cowan, the conference participants at APPAM and AEFP for valuable comments and suggestions, and the Smith Richardson Foundation for financial support (20181904). Note that the views expressed are those of the author and do not necessarily reflect those of the anonymous district or the institution to which the author is affiliated. Any errors are attributable to the authors.

CALDER • American Institutes for Research
1400 Crystal Drive 10th Floor, Arlington, VA 22202
202-403-5796 • www.caldercenter.org

The Effects of Middle School Remediation on Postsecondary Success: Regression Discontinuity Evidence from Florida

Umut Özek

CALDER Working Paper No. 258-0921
September 2021

Abstract

High school graduation rates in the United States are at an all-time high, yet many of these graduates are deemed not ready for postsecondary coursework when they enter college. This study examines the short-, medium-, and long-term effects of remedial courses in middle school using a regression discontinuity design. While the short-term test score benefits of taking a remedial course in English language arts in middle school fade quickly, I find significant positive effects on the likelihood of taking college credit-bearing courses in high school, college enrollment, enrolling in more selective colleges, persistence in college, and degree attainment.

Keywords: remedial courses; college readiness; postsecondary outcomes; human capital

1. Introduction

High school graduation rates in the United States are at an all-time high with 84 percent of students graduating with a regular high school diploma within 4 years of starting 9th grade (McFarland et al 2019). However, many of these students are identified as not ready for postsecondary coursework when they enter college. Specifically, 68% of community college students and 40% of students attending 4-year colleges nationwide take at least one remedial course in college (Chen, 2016). This fact is problematic for two reasons. First, remediation while in college is costly for both colleges and students.[1] Second, the existing literature on remedial college courses shows little evidence that these courses improve academic or labor market outcomes for students (e.g., Boatman & Long, 2018; Martorell & McFarlin, 2011).

A natural question is the extent to which K–12 remediation policies designed to address the academic needs of students earlier on are more effective in improving student outcomes and experiences in middle and high school, and thus better preparing them for college. In this study, I focus on a popular targeted means of improving the achievement levels of low-performing students at the middle school level: the requirement that students who are academically struggling in a subject take a remedial course in addition to the regular course in that subject. In particular, I examine the short-, medium-, and long-term effects of Florida's middle school remediation policy, which requires students to be placed in a remedial schedule in English language arts (ELA) if they score below the proficiency cutoff on prior year reading test, using a regression discontinuity (RD) design.

[1] A 2011 report by the Alliance for Excellent Education estimated that the total cost of delivering remediation (including direct costs to students and colleges, such as tuition and instructional costs, as well as foregone wages because of the greater likelihood that students in remedial courses will drop out of college) was $5.6 billion in the 2007–08 academic year. A recent report by the Center for American Progress concluded that college students nationwide pay roughly $1.3 billion in tuition for remedial courses (Jimenez et al. 2016).

There is extensive literature examining the efficacy of reading interventions in middle and high school. Several studies provide reviews of the experimental and quasi-experimental literature in this context (Baye et al., 2019; Edmonds et al., 2009; Herrera, Truckenmiller, & Foorman, 2016; Scammacca et al., 2007; Wanzek et al., 2013), and look for common features across programs and policies with positive effects on student reading skills.[2] However, as noted in Suggate (2016), little is known about the effects of reading interventions at the secondary level beyond their effects on reading test scores in the short run.

Another strand of literature that is closely related to this study is on the effects of "double dose" of instruction in remediation subjects for struggling students.[3] For example, Taylor (2014) uses an RD design to examine the effects of double-dose math instruction in sixth grade in Miami-Dade school district in Florida and finds large effects on achievement in math that decay over time, and that math instruction crowds out instruction in other subjects, especially physical education. Nomi and Allensworth (2009) and Cortes, Goodman, and Nomi (2015) examine the effects of an increase in algebra instruction time in Chicago in 9th grade and find positive test score effects in the short run, and significant positive effects on longer term outcomes such as high school graduation and postsecondary enrollment. Dougherty (2015) investigates the effects of increasing reading instruction time in sixth grade for struggling students in an anonymous district on test scores in the short run, and finds significant negative effects of the policy on racial

[2] For example, Herrera et al. (2016) examine studies published during the past 20 years using What Works Clearinghouse (WWC) standards and found 12 studies (out of 33 studies that satisfied the WWC standards) with positive effects on reading comprehension, vocabulary, or general literacy. They revealed several commonalities across these "effective" programs: (a) most of them included instructional elements such as explicit instruction in reading comprehension or use of instructional routines; (b) the programs or practices could be implemented within the structure of a typical middle-school language arts or content-area classroom; and (c) interestingly, none of the effective programs was implemented in a high school setting.

[3] Similar to Florida's ELA remediation policy, many of the "double dose" instruction policies examined in the literature increase instruction time for students in need of remediation (determined based on prior year test scores) to provide remedial instruction in fundamental skills in the subject of remediation.

minorities.[4] This study complements the existing literature by exploring the causal effects of remedial courses in ELA in middle school (grades 6 through 8) on college enrollment, selectivity, persistence, and completion as well as their effects on human capital accumulation in middle and high school (as proxied by advanced course-taking and test scores) that might be driving these effects in an RD design.

In terms of educational inputs, I find significant effects of Florida's middle school remediation policy on instructional time, teacher quality, class size, and peer quality in the year of remediation. In particular, taking a remedial ELA course increases instruction time in ELA by nearly an hour each day, reduces average ELA class size by roughly 2 students, and increases the likelihood that these students are assigned to more effective teachers (as proxied by their contribution to student test scores), yet reduces peer prior achievement by 0.45 standard deviations (0.45σ) in ELA courses.

I also show that the additional course in ELA does not crowd out courses in other core subjects (i.e., math, science, and social studies), yet it does reduce the likelihood that the student takes courses in music and/or physical education. That said, taking a remedial ELA course does lead to these students being placed in lower tracks not only in ELA, but also in other core subjects during the remediation year. Specifically, taking a remedial ELA course reduces the likelihood of taking advanced courses by 14 percentage points (or by 75 percent of the control

[4] There is also a growing literature on the effects of tracking policies in middle school on student outcomes. The most common example in this context is math acceleration programs that place higher-performing students in more advanced math courses in middle school. For example, McEachin, Domina, and Penner (2020) examine the effects of early algebra programs in California, which allow 8th graders who score above a certain threshold on the 7th grade math test to take Algebra I, and find significant benefits on test scores and advanced course-taking in high school, especially in schools where the eligibility threshold was set higher on the achievement distribution. Similarly, Dougherty et al. (2017) find positive effects of math acceleration in middle school on advanced course-taking in high school, college readiness scores, and college aspirations in North Carolina. On the other hand, several studies reveal negative effects of middle school math acceleration programs on math achievement in high school (Clotfelter, Ladd, and Vigdor 2015; Domina et al. 2015).

mean at the cutoff) in ELA, by 7 percentage points in math (34 percent of control mean at the cutoff), by 6 percentage points in science (73 percent), and by 5 percentage points in social studies (50 percent). As such, the policy does not only introduce an additional ELA course for struggling students, but it also changes other educational inputs such as teacher and peer quality, class size, and types of courses taken in other subjects during the year of remediation.

In terms of student outcomes in the short-term, the results reveal a significant effect on reading scores (equivalent to 0.11σ) in the year of remediation that dissipates in the following two years. I also show that taking a remedial ELA course does not have any significant effect on advanced course taking in the following two years, does not increase the likelihood that the student is involved in a severe disciplinary incident (that leads to a suspension), or the absence rate.

In terms of high school and postsecondary outcomes, I find significant benefits of remedial courses in middle school.[5] Specifically, the results indicate that taking a remedial ELA course in middle school increases the likelihood that the student takes a college credit-bearing ELA course (e.g., Advanced Placement) in high school by 3.5 percentage points (or by 38 percent of the control mean at the cutoff), in social studies by 3.6 percentage points (or by 20 percent), and overall by 4.9 percentage points (or by 21 percent). These benefits seem to spill over to postsecondary outcomes: Middle school remediation in ELA increases the likelihood of ever enrolling in college by 2.7 percentage points (or 5 percent of the control mean at the cutoff), increases the likelihood of ever attending a "very competitive" college (based on NCES-Barron's

[5] An important caveat in the postsecondary analysis is high attrition rates from the sample between the time the students were subjected to remediation in middle school until they reach the end of 12^{th} grade, which is a necessary condition to be included in the National Student Clearinghouse search. That said, as I detail below, I present considerable evidence that the postsecondary results are not driven by differential attrition from the sample at the remediation cutoff.

Admissions Competitive Index) by 4.6 percentage points (nearly 50 percent), persistence in college beyond the first year by 4.6 percentage points (15 percent of the control mean at the cutoff), persistence beyond the second year by 4.7 percentage points (22 percent), and attaining a 2-year or a 4-year degree by 3.7 percentage points (or by 43 percent of the control mean at the cutoff). I also find suggestive evidence that these benefits are larger for girls with higher extant human capital at the time of remediation as proxied by their prior math scores.

To put these numbers in context, it is helpful to compare them to other estimates in the K-12 remediation literature. Using Florida data, Schwerdt, West, and Winters (2017) examine the long-term effects of Florida's third grade retention policy. They find significant positive test score effects that dissipate in middle school (when comparing the same-year outcomes of retained and promoted students) and no significant effect on advanced course-taking in high school, high school graduation, or college enrollment. Figlio and Özek (2020a) explore the effects of the same policy on English learners and find that retention nearly doubles the likelihood of taking an advanced math or science course in middle school and roughly triples the likelihood of taking a college-credit bearing course in high school. More related to the research question addressed in this study, Cortes, Goodman, and Nomi (2015) find that double-dose of Algebra in 9th grade increases the likelihood of graduating from high school in four years by 9.8 percentage points (21 percent of the control mean at the cutoff) and the likelihood of enrolling in college by 10.8 percentage points (or by 40 percent). As such, the effects on high school and postsecondary outcomes presented in this study are comparable to the positive effect sizes found in other studies that look at the long-term effects of K-12 remediation policies.

There are several concerns regarding remediation programs such as the one examined in this study, ranging from the possible adverse effects of classroom segregation (e.g., student disengagement from schooling) to the adverse effects of remedial courses crowding out important electives (e.g., Career and Technical Education courses in high school). The findings of this study suggest that the benefits of remediation (when adequate resources are allocated to students in need) could outweigh these potential costs in a middle school setting where student dropout is less of a concern and remediation crowds out presumably less consequential electives compared to high school. As such, middle school remediation could serve as an effective lever to address the academic needs of students and prepare them for more advanced coursework in high school and college.

2. Florida's Middle School Remediation Policy

Enacted in 2004 for ELA (s.1003.415) and later expanded in 2006 (s.1003.4156), Florida's middle school remediation policy requires all middle school students who score below the proficient level on standardized tests in reading or mathematics to be subject to remediation in the corresponding subject in the following year. The policy was part of a broader shift towards student-level accountability in Florida (preceded by the 3rd grade retention policy that was enacted in 2002) where standardized test scores carried significant ramifications for students. In particular, the legislation states that each year a student scores in the lowest two achievement levels (out of five) on the standardized, statewide reading or mathematics assessment,[6] the student takes two courses in the remediation subject—a regular course and a remedial course—instead of just one course.

[6] Governor Rick Scott signed new legislation in 2015 (HB 7069), which eliminated the state remediation mandate for middle school students who are low performing and leaving the decision to districts, yet many districts in Florida still require low-performing students to take these courses in middle school. Looking at the remedial course enrollment numbers, I did not find any districts that eliminated the use of remedial courses after 2015. That said, I found 21 districts (out of the 67) that experienced a significant drop in remedial course enrollment (a drop of more than 50%) in the 2016–17 school year whereas 38 districts (including the large urban school district I utilize in this study) experienced small declines in remedial course enrollment of less than 20%.

There are several exemptions to this requirement. For example, low-performing students who do not have intervention needs in the areas of foundational reading skills (e.g., decoding, fluency) or students who have consistently scored above the proficient level in the past may be exempt from ELA remediation. Schools also have discretion over the final schedule of the student—low-performing students may be exempt, for example, if the need for remediation in math is greater than the student's need for reading remediation. Despite these exemptions, a significant portion of middle school students were affected by this policy in ELA. For example, in the large, urban school district (LUSD) in Florida that I examine in this study, 22 percent of all middle school students took a remedial ELA course in 2006-07 school year. In contrast, remedial course-taking in math was much less common in the LUSD during this time frame: Only 6 percent of all middle school students took a remedial math course in 2006-07. As such, I focus on the effects of remedial ELA courses in middle school in this study.

While the legislation provides districts flexibility in the design of ELA remediation, it provides several guidelines for implementation. For example, the policy requires districts to provide differentiated support based on the academic needs of students in the remedial schedule. In particular, the remedial course may be tailored towards foundational reading skills if the student has intervention needs in the areas of decoding and/or text reading efficiency whereas the course may provide a content area reading intervention in the specific subject area (e.g., science, social studies) for other students. The policy also requires remedial course teachers to have the Reading Endorsement or Certification in Reading and to have evidence of success (as determined by the district). Further, classroom infrastructure (class size, materials, etc.) in remedial courses needs to be adequate to implement the intervention course. To illustrate the differences between remedial and other regular courses, Table 1 compares the student composition, class size, and teacher characteristics in middle school remedial and regular ELA courses in the LUSD between 2006–07 and 2011-12 school years.

The findings in Table 1 reveal significant differences between remedial and regular courses. For example, because the policy targets low-performing students, students enrolled in remedial courses in middle school had significantly lower prior-year test scores, were more likely to receive subsidized meals, and were more likely to be Black. Remedial courses had smaller class sizes compared to regular courses (15.6 students versus 18.6 students in ELA). There are also significant differences in teacher characteristics between remedial and regular ELA courses. In particular, teachers assigned to remedial courses had significantly higher experience (a difference of roughly 1.5 years), were significantly less likely to be early career teachers (0-2 years of experience), more likely to have an advanced degree, and have higher leave-out-year value-added scores (roughly equivalent to one standard deviation in teacher value-added scores).[7] Remedial ELA teachers were also more likely to be Black and less likely to be White, which could be driven by differences in racial composition of students and teachers in schools where ELA remediation is more common. All these differences are statistically distinguishable from zero at the 1% level.

Florida's reading remediation policy in middle school could improve student achievement in reading through four distinct channels. The first channel is increasing instruction time in the remediation subject. Several recent studies have found positive effects of additional instruction time as a policy lever to improve the achievement levels of low-performing students

[7] In particular, I calculate leave-out-year value-added scores in reading similar to Chetty, Friedman, and Rockoff (2014) using the STATA command *vam* and the reading scores of students linked to their teachers in middle school ELA courses (grades 6 through 8) between 2002-03 and 2011-12 in the anonymous district. I use the value-added scores calculated using reading test scores for ELA courses. For more information on the procedure, please see Appendix A and B in Chetty, Friedman, and Rockoff (2014).

(e.g., Figlio, Holden, & Özek 2018; Taylor 2014; and Nomi and Allensworth 2009).[8] The second channel is the delivery of course content by effective teachers.[9] Third, Florida's remediation policy could improve student outcomes through the delivery of more personalized course content in smaller classroom settings.[10] Finally, remediation could lead to more effective instruction as teachers can address the specific needs of individual students in more homogenous classrooms.

On the other hand, the policy could also have unintended consequences. For example, the policy could be detrimental for low-performing students if it crowds out instructional time in other subjects or decreases the likelihood of taking more advanced courses in middle and high school. Second, classroom segregation along prior achievement, race/ethnicity, and socioeconomic status driven by the remediation policy, as demonstrated in Figlio and Özek (2020b), could have adverse effects on students subjected to the policy. Finally, there is evidence in the literature on other forms of test-based remediation (e.g., Jacob and Lefgren, 2009; Özek, 2015), suggesting that being placed in remediation could lead to student disengagement from schooling and increase student misbehavior, absences, and dropout.

3. Data

In the analysis, I make use of detailed longitudinal, student-level administrative data from a LUSD in Florida. These data cover all students enrolled in Grades K–12 between 2005–06 and

[8] A separate thread of research has examined the effects instruction time driven by unexpected school closures. Marcotte (2007) and Marcotte and Hemelt (2008) found some evidence that weather-related closures cause decreases in achievement; in contrast, results from Goodman (2014) cast some doubt on the effects of weather-related school closures.

[9] There is abundant evidence in the literature illustrating the profound effects of effective teachers on student outcomes (e.g., Chetty, Friedman, & Rockoff 2014; Ehrenberg, Goldhaber, & Brewer 1995; Jackson, 2018; Kane & Staiger, 2008; Koedel, 2008). For example, Rivkin, Hanushek, and Kain (2005) and Kane and Staiger (2008) showed that having a teacher at the 85th percentile versus 15th percentile of the test score value-added distribution increases student test scores by 8 to 20 percentile points. As such, Florida's policy could improve reading achievement by requiring effective teachers to be assigned to remedial reading courses.

[10] Chingos (2013) provides a detailed analysis on the benefits and costs of large-scale reductions in class size, and summarized that a 10-student reduction in class size leads to an increase of 7% of the standard deviation in test scores based on research by Krueger (1999).

2018–19 school years and include reading and mathematics scores of all tested students.[11] In the analysis, I use these test scores as outcomes of interest and the running variable in the RD design. In addition to these test scores, the data set includes demographic information on students, such as race, gender, free-or-reduced price lunch (FRPL) eligibility, English learner status, exceptional/special education status, country of birth, language spoken at home, student age, and schools attended. I also observe detailed course enrollment records (including unique course identifiers and name, which I use to identify remedial and advanced courses, and teacher identifiers), detailed information about student disciplinary problems, and attendance. Finally, these K–12 records are linked to National Student Clearinghouse (NSC) records for students who graduated from a high school in the district between 2013 and 2018 which allow me to observe postsecondary enrollment, college selectivity and completion for students.

LUSD is an opportune locale for this study for two reasons. First, LUSD is one of the largest school districts in the United States, with more than 200,000 enrolled students. The district's size combined with the large share of middle school students taking remedial ELA courses alleviate concerns regarding statistical power in an RD design. Second, LUSD has a diverse student body (38% Hispanic, 26% African American, 60% receiving subsidized meals, 11% foreign born, 32% nonnative speaker of English), which allows me to examine the effects of remediation on different student subgroups of interest.

4. Empirical Framework

To estimate the causal effect of Florida's middle school ELA remediation policy, I rely on an RD design using the student-level treatment cutoffs based on the prior year reading scores

[11] These include Florida Comprehensive Assessment Test (FCAT) scores in reading and mathematics for all students in Grades 3–10 until the 2011–12 school year; FCAT 2.0 scores in reading for Grades 3–10 and in mathematics for Grades 3–8 between 2012–13 and 2014–15; and Florida Standards Assessment (FSA) scores in reading for Grades 3–10 and in mathematics for Grades 3–8 since 2014–15.

of students. Panel (A) in Figure 1 presents the likelihood of taking a remedial course in ELA around the cutoff between achievement level 2 and 3 (i.e., the remediation cutoff) based on prior year reading test scores. The findings suggest that middle school students whose prior year reading scores fall right below the remediation cutoff are roughly 45 percentage points more likely to take a remedial ELA course compared to student on the other side of the cutoff.[12]

Using this non-linearity in remedial course-taking, I estimate the causal effect of remedial ELA courses on student outcomes in a fuzzy RD framework. Let S_{igt} denote the difference between the prior year reading score of student *i* who was in grade *g* in year *t* and the remediation cutoff (with negative values indicating scores below cutoff), B_{igt} denote an indicator for students below the cutoff, and R_{igt} is an indicator for students taking a remedial ELA course in the current year. In this setting, I estimate the causal effect of taking a remedial ELA course in the following 2SLS framework:

$$R_{igt} = \gamma + \delta B_{igt} + k(S_{igt}) + k(S_{igt}) * B_{igt} + \eta_{gt} + \upsilon_{igt} \quad (1)$$

$$Y_{igt} = \alpha + \beta \widehat{R_{igt}} + k(S_{igt}) + k(S_{igt}) * B_{igt} + \rho_{gt} + \vartheta_{igt} \quad (2)$$

where Y_{igt} is the outcome of interest (e.g., postsecondary outcomes, course-taking, test scores, disciplinary incidents, or absences), $k(S_{igt})$ is a polynomial function of the relative test score, and η_{gt} (and ρ_{gt}) are middle school grade-by-year fixed-effects respectively. In the main results, I present $\hat{\beta}$ (unless otherwise noted) and discuss the reduced-form estimates in Section 5. I estimate this model using the linear polynomial specification and a bandwidth of 10 points

[12] It is important to note that there is a considerably smaller discontinuity in remedial course-taking at the cutoff between achievement level 1 and 2, with students scoring right below being 15 percentage points more likely to take a remedial ELA course. In this study, I focus on the 2/3 cutoff for two reasons. First, the policy identifies students in need of remediation based on the 2/3 cutoff. Second, because the first-stage is weaker due to the smaller discontinuity in treatment at the 1/2 cutoff, statistical power becomes an issue especially when examining the effects on long-term outcomes.

based on the range of bandwidths suggested for various outcomes by the bandwidth selection procedure in Calonico et al. (2017), and check the robustness of the findings to different bandwidths and polynomial specifications in Appendix Figure 3. I cluster the standard errors at the prior year test score level as suggested by Lee and Card (2009).[13]

The critical identification assumption in this empirical framework is that observed and unobserved student attributes are smooth around the cutoff. The first column in Table 2 presents the results of a falsification test where each row represents a separate regression using the identified variable as the dependent variable estimated using the bandwidth of 10 points and the linear polynomial specification in (1-1), and the estimated coefficient indicates the size of the discontinuity (the numbers in brackets represent the control mean at the cutoff). Out of the 14 estimates, only 3 of them are statistically distinguishable from zero at conventional levels, and none of the estimates imply a discontinuity larger than 5 percent of the dependent variable mean at the cutoff.[14]

Second, I check for the possibility of selection variable manipulation as noted in McCrary (2008), even though this is very unlikely in this context since scores are assessed without any teacher, student, or principal involvement. Appendix Figure 1 presents the distribution of students around the remediation cutoff, and present no unusual discontinuity at the cutoff. I reject the hypothesis on discontinuity in the density of the distribution at the cutoff, with a p-value of 0.183 (Frandsen, 2017).

[13] This clustering approach has been recently questioned (Kolesár and Rothe 2018), and I check the robustness of the findings and compare the 95% confidence intervals obtained using standard errors clustered at the running variable level with confidence intervals obtained using Eicker-Huber-White heteroskedasticity-robust standard errors in Appendix Figure 3. These two approaches yield very similar conclusions using different bandwidths for the main outcomes of interest. Because students can be observed in the sample multiple times in different grades, I also two-way cluster standard errors at the student and the running variable and find that the conclusions remain unchanged.
[14] In the main analysis, I control for these baseline characteristics to improve the precision of the estimates. That said, I find that main results are robust to the exclusion of these covariates.

I am interested in three sets of student outcomes in the analysis. The first is ELA test scores, suspensions, absences, and advanced course-taking in the first three years after the remediation.[15] The second is high school graduation and course-taking: I am particularly interested in the likelihood of taking college credit-bearing courses in high school, which has been shown to improve postsecondary outcomes for students (Smith, Hurwitz, and Avery 2017). Third, I am interested in postsecondary outcomes including enrollment, college selectivity, persistence beyond first and second years, and degree attainment. For the first two sets of student outcomes, I use middle school students in grades 6 through 8 between 2006-07 and 2011-12 school years who were old enough to graduate from high school by the end of the sampling frame (assuming on-time grade progression).[16] The first two columns of Appendix Table 1 present the baseline characteristics of all students in these cohorts (first column) and students within 10 points around the ELA remediation cutoff (second column). For postsecondary outcomes, I use 6th graders between 2006 and 2010, 7th graders between 2007 and 2011, and 8th graders between 2008 and 2012, who were appropriately aged to be observed in NSC records assuming on-time grade progression.[17]

An important concern in this framework when examining the effects on high school and postsecondary outcomes is how to treat students who leave LUSD public schools before the end of high school. Of the students in the broader sample (used to estimate the effects on the first two sets of outcomes), 60 percent are observed in 12th grade whereas this number is 61 percent for the sample used in the postsecondary analysis. Appendix Table 1 compares the baseline

---

[15] I focus on the first three years because standardized testing in reading ends in 10th grade in LUSD, which allows me to look at test score effects only for three years for students subjected to remediation in 8th grade.
[16] While Florida changed its statewide standardized test several times since 2006-07 school year, because I focus on cohorts between 2006-07 and 2011-12 school years, the running variable in the analysis (i.e., prior year reading scores) is based on FCAT scores.
[17] I pool all middle school grades for the sake of brevity and statistical power and inspect the differential effects by grade of remediation in the subgroup analysis.

characteristics of the attriters and stayers, and shows that students who left LUSD public schools before 12th grade had significantly lower prior year test scores, were more disadvantaged economically, and were significantly more likely to speak a language other than English at home.

One approach to deal with these students is to drop them from the high school and postsecondary analysis; however, this is likely problematic as attrition can be regarded as a dependent variable to the extent that it reflects student disengagement from schooling, which may be influenced by remediation. In the main high school and postsecondary analysis, I assume that all attriters are dropouts (i.e., they end their schooling after they leave LUSD public schools) and assign them the "negative" outcome (e.g., did not receive a high school diploma or enrolled in college) as (1) they are expected to fare worse given their baseline characteristics and the possible adverse effects of student mobility, and (2) the fact that many of them were indeed high school dropouts (given that nearly half of the attriters left LUSD after age 16 when they could legally drop out in Florida).[18] I check the robustness of the findings to excluding the attriters in Section 5.3.[19]

Nevertheless, both approaches should yield similar results in a regression discontinuity framework if attrition rates are similar *and* those who leave the sample are comparable around the cutoff. Figure 2 checks the discontinuities in attrition rates by grades 9 through 12 at the remediation cutoff using the postsecondary analysis sample, and reveal no significant discontinuities in these attrition rates. In particular, I find a discontinuity of -0.008 (p-value:

[18] For high school course-taking, I assume that the attiters did not take a college credit-bearing course after they left LUSD public schools. Unfortunately, the data do not allow me to distinguish between students who left LUSD public schools to attend another school and those who left schooling altogether.
[19] It is important to note that leaving attriters in the sample and assigning them the "negative" outcome is not an ideal solution in the postsecondary analysis in that it changes the interpretation of the effect to an impact on the joint probability of remaining in the sample and attaining the postsecondary outcomes of interest. That said, as I detail in Section 5.3, the fact that the results are robust to the exclusion of attriters and the evidence showing that differential attrition is not a major issue (as presented in Figure 2 and Table 2) suggest that the estimated effects mainly capture the effect on the postsecondary outcome of interest.

0.319) for the likelihood of leaving the sample by the end of 9th grade, a discontinuity of -0.009 (p-value: 0.504) for leaving by the end of 10th grade, -0.011 (p-value: 0.446) for leaving by the end of 11th grade, and 0.003 (p-value: 0.813) for leaving by the end of 12th grade.[20] Further, to examine the extent of differential attrition, I repeat the falsification exercise presented in Table 2 conditional on staying in the sample until 12th grade (results provided in the second column of Table 2), and find strong evidence that differential attrition is not a major concern in the analysis.

Finally, an important concern in estimating the long-term effects of the policy is the dynamic treatment assignment issue discussed in Taylor (2014). Specifically, as mentioned earlier, students can be subjected to remediation multiple times through middle and high school unless they score above the remediation cutoff under Florida's policy. As a result, a student's remediation in a later grade is partly a function of remediation assignment in the current grade (as future remediation is a function of current test scores). This could imply that the long-term effects of remediation obtained using Equations (1) and (2) could underestimate the true benefits (or the unintended effects) of remedial courses if these courses reduce the need for future remediation. Appendix Figure 2 checks the discontinuities in the likelihood of taking a remedial ELA course in following years at the current year remediation cutoff, and reveals no significant discontinuities, providing evidence that dynamic treatment assignment is not a major issue in this analysis.

5. Results

5.1. Estimated Effects in the Short-Term

I first examine the effects of taking a remedial ELA course on a number of potential mediators such as instructional time, class size, teacher experience, and peer characteristics in

[20] It is important to note that those who stay in this sample until the end of 12th grade are included in the NSC search.

ELA courses during the remediation year. Panels (B) to (F) in Figure 1 present the discontinuities in weekly minutes spent in ELA courses, average class size, average leave-out-year value-added scores of teachers in ELA courses, average prior year test scores and average FRPL eligibility of classroom peers respectively.[21] The results reveal significant effects of taking a remedial course on many of these educational inputs. For example, students who score right below the remediation cutoff spend 133 minutes per week more in ELA courses. Given the first-stage discontinuity of 0.45, as presented in Appendix Table 2, this implies a treatment on the treated (ToT) effect of 295 minutes of additional instruction time per week (or nearly an hour of additional instruction time in ELA on a daily basis). Similarly, taking a remedial ELA course reduces average class size in ELA courses by about 2.5 students, and increases the leave-out-year value-added scores of teachers by 1 percent of the standard deviation in student reading scores (or 25 percent of the standard deviation in teacher value-added scores).[22] On the other hand, similar to the findings presented in Figlio and Özek (2020b), I find that students right below the remediation cutoff are enrolled in ELA courses with significantly lower-achieving (as proxied by their averaged prior year reading and math scores) and lower-SES peers (as proxied by their FRPL eligibility), with ToT effect sizes of roughly -0.56σ for peer prior achievement and 9 percentage points (or about 15 percent of the dependent variable mean at the cutoff) for peer FRPL eligibility.

The last two panels of Figure 1 examine the likelihood of taking a remedial math course (panel G) and the likelihood of taking both an ELA and a math remedial course (panel H) around

[21] I calculate average class size, teacher value-added, and peer characteristics using the time spent in each classroom (minutes per week) as weights across all ELA courses the student takes in a given school year.
[22] There was a significant increase in the share of middle school students taking remedial courses following the adoption of the policy (Figlio and Özek 2020b) leading districts/schools to hire additional teachers, which could explain the observed effects on class size and teacher quality for students placed in ELA remediation.

the ELA remediation cutoff. This is an important exercise for the interpretation of findings as students above the ELA remediation cutoff might be more likely to be subjected to math remediation. The findings reveal no significant discontinuities on the likelihood of taking a remedial math course or remedial courses in both subjects, suggesting that the observed discontinuities in student outcomes at the ELA remediation cutoff are primarily driven by the change in the likelihood of taking a remedial ELA course.

What about courses in other subjects? Given that ELA remediation is provided without extending the school day, an important concern is that taking a remedial course could crowd out courses in other subjects. Panel (A) in Figure 3 presents the effects of taking a remedial ELA course estimated using Equations (1) and (2) on the number of courses taken during the remediation year by subject. The findings reveal no significant effect on the number of courses taken in other core subjects (math, science, or social studies) and that remediation primarily crowds out physical education and music courses. [23]

That said, taking a remedial ELA course has a significant effect on the *type* of courses taken in other core subjects during the year of remediation. Panel (B) in Figure 3 presents the estimated effects on the likelihood of taking advanced courses (the most advanced out of three categories) by subject during the year of remediation. Taking a remedial ELA course decreases the likelihood of taking an advanced ELA course by 14 percentage points (or by 75 percent of the control mean at the cutoff) during the year of remediation. Remedial ELA courses also reduce advanced course-taking in other subjects by 7 percentage points in math (34 percent of control mean at the cutoff), 6 percentage points in science (73 percent), and 5 percentage points in social studies (50 percent). Taken together, these findings provide evidence that remedial

[23] I also check the effect of taking a remedial ELA course on teacher and peer quality, and class size in math courses. The results, which are available upon request, reveal no significant effect.

course-taking has a major effect on advanced course-taking in other subjects during the year of remediation not due to crowding out, but due to these students being placed in lower tracks in the year of remediation in other subjects.

Table 3 presents the estimated effects of taking a remedial ELA course on student reading scores, suspensions, absence rates, and advanced course-taking in the first three years (Figure 4 presents a graphical depiction for reading scores and advanced course-taking in the first three years). There are several results worth highlighting. For example, I find a sizable and statistically significant positive effect on reading scores (equivalent to 0.11σ) that dissipates after the year of remediation. Similarly, the negative effect on advanced course-taking mostly vanishes (except for the statistically significant negative effect in the second year on advanced ELA course-taking) after the remediation year, suggesting that students in the remedial schedule are no more likely to be placed in lower tracks beyond the first year. Further, I find no significant adverse effect of remediation on severe disciplinary problems that lead to suspensions or absence rates. Most of these second- and third year effects are not only statistically insignificant, but also small in magnitude compared to the dependent variable means (at the cutoff) presented in brackets.

5.2. Estimated Effects on High School and Postsecondary Outcomes

Table 4 presents the estimated effects of taking a remedial ELA course in middle school on high school and postsecondary outcomes (graphical illustrations provided in Figure 5). In particular, the first panel presents the effects on the likelihood of (1) taking college credit-bearing courses in high school (Advanced Placement, International Baccalaureate, Advanced

International Certificate of Education, or dual enrollment courses) by subject and overall (in core subjects), and (2) receiving a standard high school diploma.[24]

The findings reveal significant benefits of remedial ELA courses in middle school on advanced course-taking in high school, especially in ELA and social studies. Taking a remedial ELA course increases the likelihood of taking college credit-bearing courses in ELA by 3.5 percentage points (or by 38 percent of the control mean at the cutoff), in social studies by 3.6 percentage points (or by 20 percent), and overall by 4.9 percentage points (or by 21 percent). I find no significant effect of taking a remedial course on college credit-bearing course-taking in math or science in high school, or the likelihood of receiving a standard high school diploma.

Remedial ELA courses in middle school also have significant positive effects on postsecondary outcomes. The second panel of Table 4 presents the estimated effects on college enrollment, persistence, and completion using cohorts who are old enough to be observed in NSC records. The findings suggest a small, yet statistically significant, positive effect on the likelihood of ever enrolling in college (2.7 percentage points or 5 percent of the control mean at the cutoff).[25] Given that there is no significant discontinuity at the ELA remediation cutoff in dropping out of high school (as suggested by Figure 2) and in high school graduation (Table 4), these findings suggest that ELA remediation has a positive effect on student persistence in schooling at the college enrollment margin rather than persistence in high school.[26]

[24] I also restrict the high school course-taking analysis to Advanced Placement courses and the results are very similar. I use Florida's definition to identify standard high school diplomas, which exclude certificates of completion.

[25] I also examine the effect separately on 2-year versus 4-year college enrollment. The results suggest that the effect on enrollment observed in Table 4 is primarily driven by the effect on 4-year enrollment. In particular, I find that taking a remedial ELA course in middle school increases the likelihood of enrolling in a 4-year institution by 3.1 percentage points (or by nearly 10 percent of the dependent variable mean) compared to an effect size of 0.2 percentage points (or by 2 percent) for 2-year enrollment.

[26] In this exercise, I examine the effect of ELA remediation on ever enrolling in college holding grade-year constant. An alternative approach would be to examine the effects on enrolling in college within 1, 2, 3 year(s) of high school graduation. When I conduct this exercise, I find that the enrollment effects appear in the first year after high school

I also find that taking a remedial ELA course in middle school increases the likelihood of ever attending a "very competitive" college (those that are rated "very competitive" or above based on NCES-Barron's Admissions Competitive Index data for 2004) by 4.6 percentage points or by nearly 50 percent in relation to the control mean at the cutoff.[27] Further, taking a remedial course increases the likelihood that the student persists in college beyond the first year by 4.6 percentage points (15 percent of the control mean at the cutoff), and beyond the second year by 4.7 percentage points (22 percent). Consequently, remedial ELA courses in middle school have significant effects on the number of years in college and the likelihood of ever receiving a college degree (by the end of the sampling frame in NSC records). In particular, the estimated coefficients in the last row of Table 4 suggest that remedial courses increase degree attainment (2- or 4-year degree) by 3.7 percentage points (or by 43 percent of the control mean at the cutoff).[28]

While these positive effects on postsecondary outcomes seem contradictory to the short-term test score effects that dissipate over time, they are consistent with the findings of several studies in different contexts that find zero (or dissipating) test score effects, yet significant positive effects on long-term outcomes (such as educational attainment and labor market outcomes) of education policies.[29] For example, Duncan and Magnuson (2013) examine the

graduation (a positive effect of 3.3 percentage points, p-value of 0.053) and persist in the following two years, indicating that ELA remediation improves college enrollment by increasing the likelihood of "on-time" enrollment.

[27] The results, which are available upon request, are similar when I restrict the colleges to those that are ranked "competitive" or higher.

[28] It is important to note that, other than the high school graduating cohorts in 2013 and 2014, I am unable to observe students in college for at least 4 years. As such, only 12 percent of the students in the sample who received a college degree received a Bachelor's degree. That said, given that the enrollment effect is primarily driven by the effect on 4-year enrollment, it is unlikely that any positive effect observed on degree attainment is driven by a shift from 4-year to 2-year institutions.

[29] Fade-out (and persistence) of educational interventions (and the factors behind them) has been studied extensively in literature. For example, Bailey et al. (2020) conclude that persistence of educational interventions depends on a number of factors such as the types of skills targeted, constraints and opportunities within the social context, and complementarities between interventions and subsequent affordances. Similarly, Bailey et al. (2017) argue that

extant literature on the effects of preschool programs and conclude that while early childhood programs appear to boost cognitive ability and early school achievement in the short run, these cognitive impacts fade out within a few years.[30] That said, long-run follow-ups of some of these programs show lasting positive effects on educational attainment and adult earnings. One possible explanation behind this finding is that test scores, especially in middle and high school, have lower predictive validity on postsecondary and adult outcomes, compared to other measures of human capital accumulation such as course-taking and non-cognitive skills.[31]

5.3. Robustness Checks and Exclusion Restriction

Appendix Figure 3 checks the sensitivity of the main findings to bandwidth and polynomial degree selection, and provides the effects (and the 95% confidence intervals) of taking a remedial ELA course in middle school estimated using different bandwidths and linear and quadratic polynomial specifications. In particular, each spike presents the β coefficient estimated using linear $k(S)$ (for smaller bandwidths between 10 and 16) and quadratic $k(S)$ (for bandwidths between 18 and 30) in equations (1-1) and (1-2). These figures also compare the 95% confidence intervals obtained using standard errors clustered at the running variable level (solid spikes) with confidence intervals obtained using Eicker-Huber-White heteroskedasticity-robust standard errors (dashed spikes).

The estimated discontinuities at the cutoff are very robust to bandwidth selection, especially for middle and high school outcomes. For postsecondary outcomes, 95% confidence

---

successful interventions equip a child with the right skills or capacities at the right time to avoid imminent risks or seize emerging opportunities.

[30] Hitt, McShane, & Wolf (2018) examine the relationship between the test score effects and long-term effects of school choice programs in the existing literature, and note a number of studies that find zero (or dissipating) effects on the former, yet positive and significant effects on the latter.

[31] Indeed, Jackson (2018) finds evidence suggesting that teacher effects on non-test-score outcomes in 9th grade such as absences, suspensions, course grades, and on-time grade progression predict effects on high-school completion and predictors of college-going above and beyond their effects on test scores.

intervals occasionally include zero mainly due to smaller sample sizes, but even so, the estimated coefficients are statistically different than zero at the 10 percent level or higher in 14 cases (out of 22) for college enrollment, all cases for “very competitive” college enrollment, 21 cases for persistence beyond first year, 21 cases for years in college, and all cases for college degree attainment.

Appendix Table 3 checks the robustness of the main findings to the exclusion of attriters and to nonparametric estimation using optimal bandwidths. In particular, the first and third columns of the table presents the effects estimated parametrically using a bandwidth of 10 points and all students (first column) and students who remained in LUSD until 12th grade (third column). The second and fourth columns repeat the same analysis using the nonparametric approach developed by Calonico et al. (2017). While the point estimates vary slightly across specifications and the standard errors increase when excluding the attriters, main conclusions remain unchanged. These findings are also consistent with the results in Figure 2 and the second column of Table 2, which provide evidence against differential attrition.

A potential concern in the 2SLS framework utilized in this study is the possibility that the exclusion restriction is violated. That is, if students who were exempt from the policy receive other types of ELA remediation (e.g., remediation in regular courses) when they score below the ELA remediation cutoff, the 2SLS estimates presented thus far will likely overestimate the true benefit of remedial courses. This bias is expected to be more pronounced if the effect of this alternative remediation is comparable to (or larger than) the effect of taking a remedial ELA course.

To check whether this is the case, I examine differences in educational inputs (i.e., instructional time, class size, teacher experience, classroom peer quality) between low-performing students (whose prior year reading scores fell below the remediation cutoff) who took remedial ELA courses versus those who were exempt, holding prior year test scores and other student attributes listed in Table 2 constant. The findings reveal significant differences in educational inputs between these two student groups in the year of remediation. Low-performing students who take remedial ELA courses spend roughly 200 minutes more per week in ELA courses, are assigned to smaller classrooms (by about 1 student) with more experienced teachers (with 1 more year of experience) and with peers with lower prior achievement (0.24σ) compared to observationally similar students who were exempt from the policy. These findings provide suggestive evidence that (a) exempt students are not subject to other forms of ELA remediation and/or (b) the effect of this alternative remediation is likely much smaller compared to the true effect of remedial ELA courses.

Nevertheless, Appendix Table 4 presents the estimated effects of scoring below the remediation cutoff. These reduced-form estimates, which can be regarded as a lower-bound for the true effect of remedial ELA courses on student outcomes, still reveal sizable benefits on high school and postsecondary outcomes. For example, scoring below the ELA remediation cutoff increases the likelihood of taking a college credit-bearing course in ELA by nearly 20 percent (of the control mean at the cutoff), and in all core subjects by 10 percent, enrolling in a "very competitive" college by 25 percent, enrolling in college beyond the first year by 15 percent, and receiving a degree by 25 percent of the control mean at the cutoff.

5.4. Heterogeneous Treatment Effects

Do the observed benefits of middle school remediation vary by grade of remediation or by student attributes? This is an important exercise as there are several reasons why remediation could have different effects along these dimensions. For example, addressing academic needs in earlier grades (before students are exposed to more challenging course content) could be more beneficial for students, which has been shown in the context of grade retention policies (Jacob & Lefgren 2009; Schwerdt et al. 2017). Similarly, remediation could have different effects for racial minorities if it leads to feelings of being singled out (or discriminated against), which in turn could lead to disengagement from schooling (e.g., Dougherty 2015). ELA remediation may also be more beneficial for students who do not have academic needs in multiple subjects or for students who are more likely to pursue careers in fields that require higher competency in ELA.

In the Online Appendix, I present an exploratory exercise examining heterogeneous treatment effects along several student attributes. Perhaps the most interesting takeaway from this analysis is the discrepancies between the effects on high-performing girls and others. Specifically, among higher-performing girls, taking a remedial ELA course in middle school increases the average reading scores in the first three years by 0.11σ, nearly doubles the likelihood of taking a college credit-bearing course in ELA, increases this likelihood by 12 percentage points (30 percent) in social studies, increases the likelihood of enrolling in college by 17 percentage points (roughly 30 percent), nearly doubles the likelihood of enrolling in a "very competitive" college, increases persistence beyond first and second years by 18 and 15 percentage points (30 and 50 percent respectively), and degree attainment by 9.5 percentage points (50 percent). All these effects are statistically different than zero at 10 percent or higher. Further, all estimated effects on postsecondary outcomes for higher-performing girls are statistically distinguishable from the estimated coefficients for males or students who were not proficient on prior year math test at 10 percent level or higher. Given that girls are more likely to pursue careers in fields that require higher competency in ELA and social studies (e.g., English Language and Literature, Journalism, Communication), these findings seem to suggest that ELA remediation in middle school helps these students succeed in college by helping them acquire higher human capital in ELA and social studies in middle and high school.

6. Concluding Remarks

Improving college readiness for all students remains at the top of the state and federal education policy agenda. College enrollment rate in the United States has been on the rise over the last three decades with roughly 70 percent of high school completers entering college immediately after high school graduation in 2016 (compared to 60 percent in 1990). Yet, many of these students are deemed not ready for college-level coursework and are required to take remedial courses while in college. Therefore, it is important to better understand whether remediation in middle and high school could serve as an effective policy lever to improve the college readiness of students.

In this study, I examine the causal effects of Florida's middle school remediation policy on postsecondary outcomes including enrollment, college selectivity, persistence, and degree attainment. This policy requires students whose prior year reading scores fall below the proficient level to take a remedial course in addition to the remedial course in ELA, which enables me to use a regression discontinuity design for identification of the causal effects. I also examine the effects of middle school remediation on human capital accumulation (as proxied by test scores and advanced course-taking) in middle and high school that might explain the postsecondary effects.

I find significant positive effects of middle school remedial ELA courses on college enrollment, likelihood of enrolling in more selective colleges, persistence in college, and degree attainment. While I find that the short-term test score benefits fade quickly, taking a remedial ELA course in middle school significantly increases the likelihood of taking college credit-bearing courses in high school, which could be an important driver of the observed effects on postsecondary outcomes. I also find suggestive evidence that these benefits are larger among girls with higher extant human capital at the time of remediation. These findings provide evidence that test-based remediation policies in middle school could serve as an effective policy lever to improve college readiness.

It is important to note several limitations of this study. First, I am unable to observe students in college long enough to assess the effect of middle school remediation in ELA on Bachelor's degree attainment separately, which typically have larger returns in the labor market, or the field of study. That said, the observed effects on the likelihood of taking college credit-bearing ELA and social studies combined with the effects on persistence in college beyond second year provides suggestive evidence that the remediation policy likely affects degree attainment in non-STEM fields and Bachelor's degree attainment. Second, similar to other studies relying on RD design for causal inference, the results presented in this study apply only to students around the remediation cutoff. As such, it is not clear that remedial courses would be as beneficial for lower-performing students.

An important concern with remediation policies at the secondary level, especially with those implemented during the regular school day, is the possible adverse effects of remediation crowding out electives that could be beneficial for students in the long-term. Further, remediation could be detrimental for students due to the decline in peer achievement and/or if it leads to student disengagement from schooling. The findings presented in this study provide evidence that the benefits of middle school remediation when implemented with adequate resources (e.g., more effective teachers, intervention tailored to student needs in smaller classes) could outweigh these potential adverse effects. That said, it is important to note that these adverse effects could be more pronounced in high school if remediation crowds out electives that are perhaps more consequential or if being placed in remediation leads to student dropout. Therefore, the effect of a similar policy in high school could be different.

These findings also speak to the current debate about the value of remediation versus acceleration as it relates to addressing low performance and learning loss.[32] There are several recent studies that find significant benefits of math acceleration policies in middle school that provide opportunities for higher-performing 8th graders to take Algebra I (e.g., McEachin, Domina, and Penner 2020; Dougherty et al. 2017). The findings of this study suggest that remediation could also be an effective strategy to help students who are behind academically when struggling students are provided additional resources.

[32] See, for example, https://unesdoc.unesco.org/ark:/48223/pf0000374029, accessed on 3/26/2021.

References

Bailey, D. H., Duncan, G. J., Cunha, F., Foorman, B. R., & Yeager, D. S. (2020). Persistence and Fade-Out of Educational-Intervention Effects: Mechanisms and Potential Solutions. Psychological Science in the Public Interest, 21(2), 55-97.

Bailey, D. H., Duncan, G., Odgers, C., & Yu, W. (2017). Persistence and fadeout in the impacts of child and adolescent interventions. *Journal of Research on Educational Effectiveness*, 10, 7-39.

Baye, A., Inns, A., Lake, C., & Slavin, R. (2019). A Synthesis of Quantitative Research on Reading Programs for Secondary Students. *Reading Research Quarterly*, *54*(2), 133–166. https://doi.org/10.1002/rrq.229

Calonico, S., Cattaneo, M., Farrell, M., & Titiunik, R., (2017). rdrobust: Software for regression-discontinuity designs. *The Stata Journal*, 17 (2), 372–404.

Chen, X. (2016). Remedial coursetaking at U.S. public 2- and 4-year institutions: Scope, experiences, and outcomes (NCES 2016-405). Washington, DC: National Center for Education Statistics, U.S. Department of Education. Retrieved from http://nces.ed.gov/pubsearch.

Chetty, Raj, John N. Friedman, and Jonah E. Rockoff. (2014). "Measuring the Impacts of Teachers II: Teacher Value-Added and Student Outcomes in Adulthood." *American Economic Review* 104 (9): 2633–79.

Chingos, M.M. (2013). Class size and student outcomes: Research and policy implications. *Journal of Policy Analysis and Management*, *32*(2), pp.411-438.

Clotfelter, C. T., Ladd, H. F., & Vigdor, J. L. (2015). The aftermath of accelerating algebra: Evidence from district policy initiatives. Journal of Human Resources, 50, 159–188.

Cortes, K. E., Goodman, J. S., & Nomi, T. (2015). Intensive Math Instruction and Educational Attainment Long-Run Impacts of Double-Dose Algebra. Journal of Human Resources, 50(1), 108-158.

Domina, T., McEachin, A., Penner, A. M., & Penner, E. K. (2015). Aiming high and falling short: California's 8th grade algebra-for-all effort. Educational Evaluation and Policy Analysis, 37, 275–295.

Dougherty, S., Goodman, J., Hill, D., Litke, E., & Page, L. C. (2017). Objective course placement and college readiness: Evidence from targeted middle school math acceleration. Economics of Education Review, 58, 141–161.

Dougherty, Shaun M. (2015). Bridging the Discontinuity in Adolescent Literacy? Mixed Evidence from a Middle Grades Intervention. *Education Finance and Policy* 10(2): 157-192.

Duncan, Greg J., and Katherine Magnuson. 2013. "Investing in Preschool Programs." *Journal of Economic Perspectives*, 27 (2): 109-32.

Edmonds, M.S., Vaughn, S., Wexler, J., Reutebuch, C.K., Cable, A., Tackett, K.K., & Schnakenberg, J.W. (2009). A synthesis of reading interventions and effects on reading outcomes for older struggling readers. *Review of Educational Research*, *79*(1), 262–300. https://doi.org/10.3102/0034654308325998

Figlio, D. & Özek, U. (2020a). An extra year to learn English? Early grade retention and the human capital development of English learners. *Journal of Public Economics*, 186, 104184.

Figlio, D. & Özek, U. (2020b). Separate under the Same Roof: The Effects of Test-Based Remediation on Classroom Segregation. CALDER Working Paper.

Figlio, D., Holden, K., & Ozek, U. (2018). Do students benefit from longer school days? Regression discontinuity evidence from Florida's additional hour of literacy instruction. Economics of Education Review, 67, 171–183.

Frandsen, B. (2017). Party bias in union representation elections: testing the manipulation in the regression discontinuity design when the running variable is discrete. Advances in Econometrics, in : Matias D. Cattaneo & Juan Carlos Escanciano (ed.), Regression Discontinuity Designs, volume 38, pages 281-315, Emerald Publishing Ltd.

Goodman, J. (2014). Flaking out: Student absences and snow days as disruptions of instructional time. National Bureau of Economic Research WP No: 20221.

Herrera, S., Truckenmiller, A.J., & Foorman, B.R. (2016). *Summary of 20 years of research on the effectiveness of adolescent literacy programs and practices* (REL 2016-178). Washington, DC: Regional Educational Laboratory Southeast, National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of Education.

Hitt, C., McShane, M. Q., & Wolf, P. (2018). *Do impacts on test scores even matter? Lessons from long-run outcomes in school choice research*. Washington, DC: American Enterprise Institute. Retrieved from http://www.aei.org/wp-content/uploads/2018/04/Do-Impacts-on-Test-Scores-Even-Matter.pdf

Jackson, C. (2018). What Do Test Scores Miss? The Importance of Teacher Effects on Non–Test Score Outcomes. *Journal of Political Economy*, *126*(5), 2072–2107. https://doi.org/10.1086/699018

Jacob, B.A. & Lefgren, L. (2009). The effect of grade retention on high school completion. *American Economic Journal: Applied Economics*, 1(3), 33-58.

Johnson, R. C. & Jackson, C. K. (2019). Reducing Inequality through Dynamic Complementarity: Evidence from Head Start and Public School Spending. *American Economic Journal: Economic Policy*, 11 (4): 310-49.

Kane, Thomas J., and Douglas O. Staiger. 2008. "Estimating Teacher Impacts on Student Achievement: An Experimental Evaluation." Working Paper no. 14607, NBER, Cambridge, MA.

Koedel, C. 2008. "Teacher Quality and Dropout Outcomes in a Large, Urban School District." J. Urban Econ. 64 (3): 560–72.

Kolesár, M. & Rothe, C., (2018). Inference in regression discontinuity designs with a discrete running variable. *American Economic Review*, 108, 2277–2304.

Krueger, A.B. (1999). Experimental estimates of education production functions. *The Quarterly Journal of Economics*, *114*(2), pp.497-532.

Lee, D. S., & Card, D. (2008). Regression discontinuity inference with specification error. Journal of Econometrics, 142(2), 655-674.

Marcotte, D. E. (2007). Schooling and test scores: A mother-natural experiment. *Economics of Education Review*, 26(5), 629-640.

Marcotte, D. E., & Hemelt, S. W. (2008). Unscheduled school closings and student performance. *Education Finance and Policy*, 3(3), 316-338.

McEachin, A., Domina, T., and Penner, A. (2020). Heterogeneous Effects of Early Algebra across California Middle Schools. *Journal of Policy Analysis and Management*, 39 (3), 772 – 800.

McFarland, J., Hussar, B., Zhang, J., Wang, X., Wang, K., Hein, S., Diliberti, M., Forrest Cataldi, E., Bullock Mann, F., and Barmer, A. (2019). The Condition of Education 2019 (NCES 2019-144). U.S. Department of Education. Washington, DC: National Center for Education Statistics. Retrieved 6/12/19 from https://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2019144.

Nomi, Takako, and Elaine Allensworth. 2009. "Double-dose" algebra as an alternative strategy to remediation: Effects on students' academic outcomes. *Journal of Research on Educational Effectiveness* 2(2):111–148.

Özek, U. (2015). Hold back to move forward? Early grade retention and student misbehavior. *Education Finance and Policy*,*10*(3): 350–377.

Rivkin, S. G., E. A. Hanushek, and J. F. Kain. 2005. "Teachers, Schools, and Academic Achievement." Econometrica 73 (2): 417–58.

Scammacca, N., Roberts, G., Vaughn, S., Edmonds, M., Wexler, J., Reutebuch, C.K., & Torgesen, J.K. (2007). *Interventions for adolescent struggling readers: A meta-analysis with implications for practice*. Portsmouth, NH: Center on Instruction, RMC Research.

Schwerdt, G., West, M. R., & Winters, M. A. (2017). The Effects of Test-Based Retention on Student Outcomes over Time: Regression Discontinuity Evidence from Florida. *Journal of Public Economics*, 152, 154–169.

Smith, J., Hurwitz, M., & Avery, C. 2017. Giving college credit where it is due: Advanced Placement exam scores and college outcomes. Journal of Labor Economics, 35(1), 67–147.

Suggate, S. (2016). A Meta-Analysis of the Long-Term Effects of Phonemic Awareness, Phonics, Fluency, and Reading Comprehension Interventions. *Journal of Learning Disabilities*, *49*(1), 77–96. https://doi.org/10.1177/0022219414528540

Taylor, E. (2014). Spending more of the school day in math class: Evidence from a regression discontinuity in middle school. *Journal of Public Economics*, 117, 162-181.

Wanzek, J., Vaughn, S., Scammacca, N.K., Metz, K., Murray, C.S., & Roberts, G. (2013). Extensive reading interventions for students with reading difficulties after grade 3. Review of Educational Research, 83(2), 163–195. https://doi.org/10.3102/0034654313477212.

Table 1. Differences in Student Composition, Class Size, and Teacher Characteristics in Middle School Remedial and Regular Courses

	Remedial	Regular
Student composition -		
Prior year reading score	-0.906	-0.019
	(0.731)	(1.005)
Prior year math score	-0.707	-0.004
	(0.916)	(0.992)
Prior year disciplinary incident	0.410	0.252
	(0.492)	(0.434)
Prior year % absent days	0.064	0.049
	(0.070)	(0.055)
FRPL eligible	0.717	0.580
	(0.450)	(0.494)
White	0.211	0.315
	(0.408)	(0.464)
Black	0.404	0.262
	(0.491)	(0.440)
Hispanic	0.341	0.351
	(0.474)	(0.477)
Male	0.553	0.508
	(0.497)	(0.500)
English non-native	0.449	0.455
	(0.497)	(0.498)
Class size	15.64	18.63
	(4.038)	(4.678)
Teacher characteristics -		
Years of experience	9.348	7.825
	(8.285)	(7.249)
0-2 years of experience	0.187	0.223
	(0.390)	(0.416)
3-5 years of experience	0.220	0.258
	(0.414)	(0.437)
6-12 years of experience	0.329	0.320
	(0.470)	(0.467)
13+ years of experience	0.254	0.189
	(0.435)	(0.392)
White teacher	0.584	0.660
	(0.493)	(0.474)
Black teacher	0.284	0.196
	(0.451)	(0.397)
Hispanic teacher	0.124	0.129
	(0.329)	(0.335)
Master's degree or higher	0.340	0.264
	(0.474)	(0.441)
Leave-out-year value-added score	0.016	0.011
	(0.046)	(0.039)

Notes: Standard deviations are given in parentheses. Reading and math scores are standardized at the grade-year level to zero mean and unit variance.

Table 2. Baseline Equivalency of Student Characteristics Around the Remediation Cutoff

		Conditional on staying in the sample until 12th grade
Prior year -		
Score in other subject	-0.009	0.006
	(0.011)	(0.012)
Took remedial ELA	-0.000	-0.003
	(0.013)	(0.016)
	[0.291]	[0.246]
Took remedial math	0.001	0.001
	(0.010)	(0.009)
	[0.091]	[0.067]
Disciplinary incident	0.011	0.007
	(0.010)	(0.012)
	[0.272]	[0.198]
% absent days	-0.001	-0.003*
	(0.001)	(0.001)
	[0.047]	[0.040]
Limited English proficient	0.009*	0.008
	(0.005)	(0.008)
	[0.190]	[0.065]
Special education	-0.009	-0.016
	(0.008)	(0.012)
	[0.146]	[0.051]
White	-0.014	-0.004
	(0.009)	(0.011)
	[0.262]	[0.247]
Black	0.008	0.010
	(0.008)	(0.015)
	[0.330]	[0.316]
Hispanic	0.017***	0.008
	(0.006)	(0.009)
	[0.348]	[0.383]
FRPL eligible	0.002	0.007
	(0.010)	(0.011)
	[0.705]	[0.698]
Male	0.013	0.012
	(0.008)	(0.010)
	[0.485]	[0.449]
U.S. born	-0.003	-0.007
	(0.004)	(0.008)
	[0.882]	[0.917]
English non-native	0.014*	0.016*
	(0.008)	(0.009)
	[0.368]	[0.354]
F-stat	1.14	0.94
p-value	0.32	0.52
Number of unique students	24,552	15,735

Notes: Robust standard errors, clustered at the prior year reading score level, are given in parentheses. The estimates represent the discontinuities in student characteristics at the remediation cutoff, obtained using linear polynomial specification and a bandwidth of 10 points. The numbers in brackets represent the predicted control mean at the cutoff. *, **, and *** represent statistical significance at 10, 5, and 1 percent, respectively.

Table 3. Estimated Effects of Taking a Remedial ELA Course on Reading Scores, Suspensions, Absences, and Advanced Course-Taking, First Three Years

	Remediation Year	1 Year Later	2 Years Later
Reading score	0.106***	0.015	0.007
	(0.019)	(0.022)	(0.015)
Suspended	0.014	-0.021	0.023
	(0.012)	(0.017)	(0.014)
	[0.259]	[0.266]	[0.234]
% absent days	0.002	-0.001	-0.003
	(0.002)	(0.002)	(0.002)
	[0.054]	[0.064]	[0.071]
Took an advanced…			
ELA course	-0.139***	-0.036**	-0.011
	(0.020)	(0.016)	(0.026)
	[0.179]	[0.229]	[0.294]
Math course	-0.073***	-0.019	-0.007
	(0.009)	(0.024)	(0.022)
	[0.214]	[0.241]	[0.252]
Science course	-0.073***	-0.023	-0.002
	(0.013)	(0.018)	(0.010)
	[0.098]	[0.145]	[0.209]
Social studies course	-0.039***	-0.006	0.014
	(0.011)	(0.019)	(0.014)
	[0.074]	[0.142]	[0.218]
First-stage	0.433***	0.434***	0.439***
	(0.005)	(0.005)	(0.005)
N	28,157	26,440	24,280

Notes: This table reports 2SLS estimates of the impact of taking a remedial ELA course on reading scores, suspensions, absences, and advanced course-taking in the first three years using equations (1) and (2). All regressions control for the baseline student characteristics listed in Table 2, and robust standard errors, clustered at the prior year reading score level, are given in parentheses. The estimates represent the treatment effect (β) on the corresponding outcome obtained using linear polynomial specification and a bandwidth of 10 points. The numbers in brackets represent the predicted control mean at the cutoff. *, **, and *** represent statistical significance at 10, 5, and 1 percent, respectively.

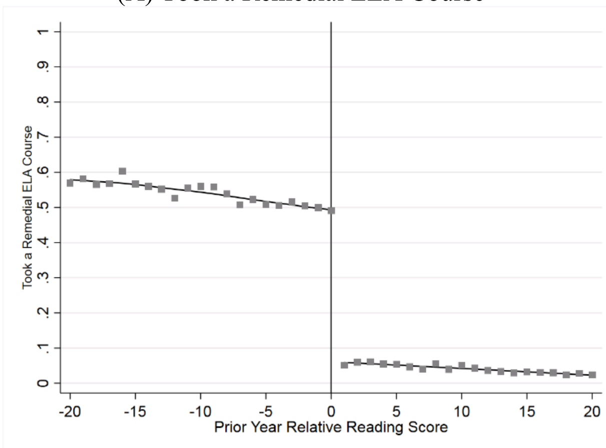
Table 4. Estimated Effects of Taking a Remedial ELA Course on High School and Postsecondary Outcomes

High School Outcomes	
Took a college credit-bearing course in…	
ELA	0.035***
	(0.010)
	[0.092]
Math	0.003
	(0.009)
	[0.048]
Science	0.009
	(0.014)
	[0.076]
Social Studies	0.036**
	(0.017)
	[0.181]
Overall	0.049**
	(0.021)
	[0.222]
Received a standard HS diploma	0.026
	(0.027)
	[0.552]
First stage	0.433***
	(0.005)
N	28,157
Postsecondary Outcomes	
Enrolled in college	0.027**
	(0.013)
	[0.418]
Enrolled in "very competitive" college	0.046**
	(0.022)
	[0.095]
Enrolled beyond first year	0.046***
	(0.017)
	[0.310]
Enrolled beyond second year	0.047***
	(0.014)
	[0.220]
Years in college	0.188***
	(0.042)
	[1.160]
Received a degree	0.037***
	(0.012)
	[0.086]
First stage	0.443***
	(0.007)
N	22,085

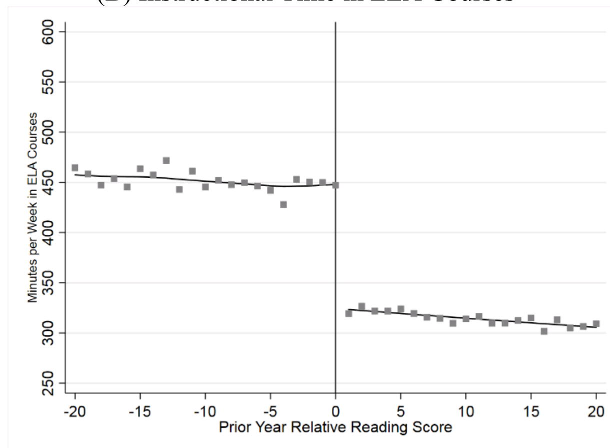
Notes: This table reports 2SLS estimates of the impact of taking a remedial ELA course on high school and postsecondary outcomes using equations (1) and (2). All regressions control for the baseline student characteristics listed in Table 2, and robust standard errors, clustered at the prior year reading score level, are given in parentheses. The estimates represent the treatment effect (β) on the corresponding outcome obtained using linear polynomial specification and a bandwidth of 10 points. The numbers in brackets represent the predicted control mean at the cutoff. *, **, and *** represent statistical significance at 10, 5, and 1 percent, respectively.

Figure 1. Remedial Course-Taking and Educational Inputs Around the Cutoff

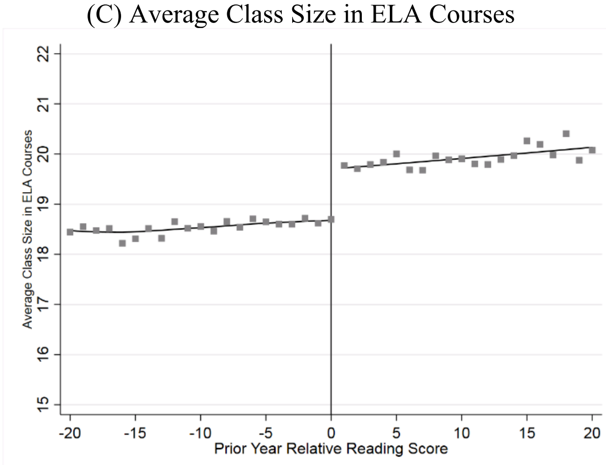
(A) Took a Remedial ELA Course



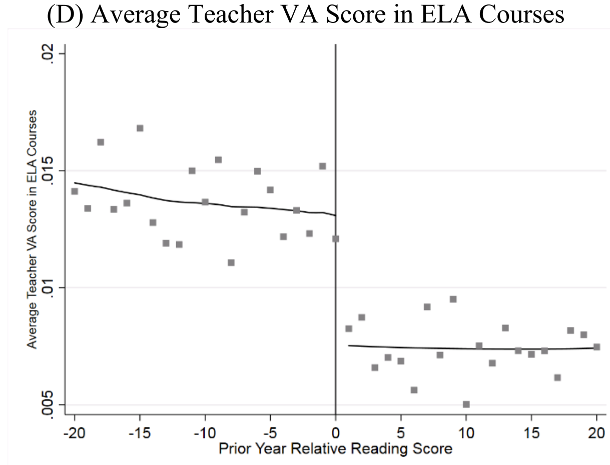
(B) Instructional Time in ELA Courses



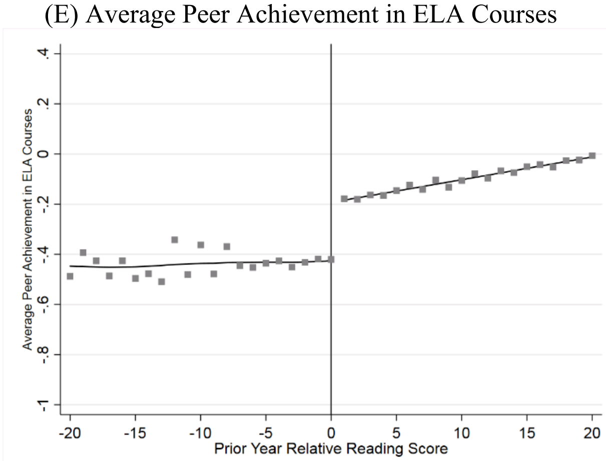
(C) Average Class Size in ELA Courses



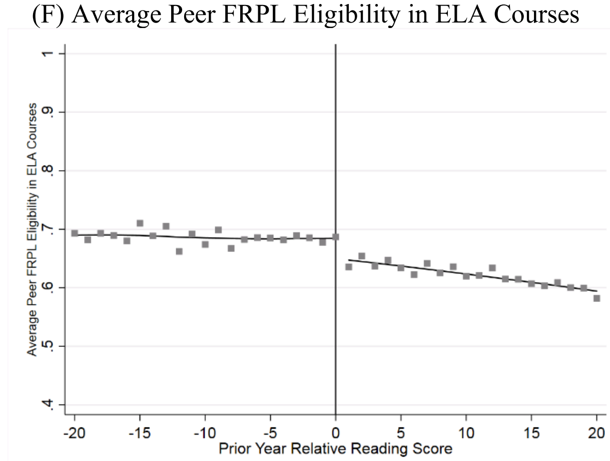
(D) Average Teacher VA Score in ELA Courses



(E) Average Peer Achievement in ELA Courses

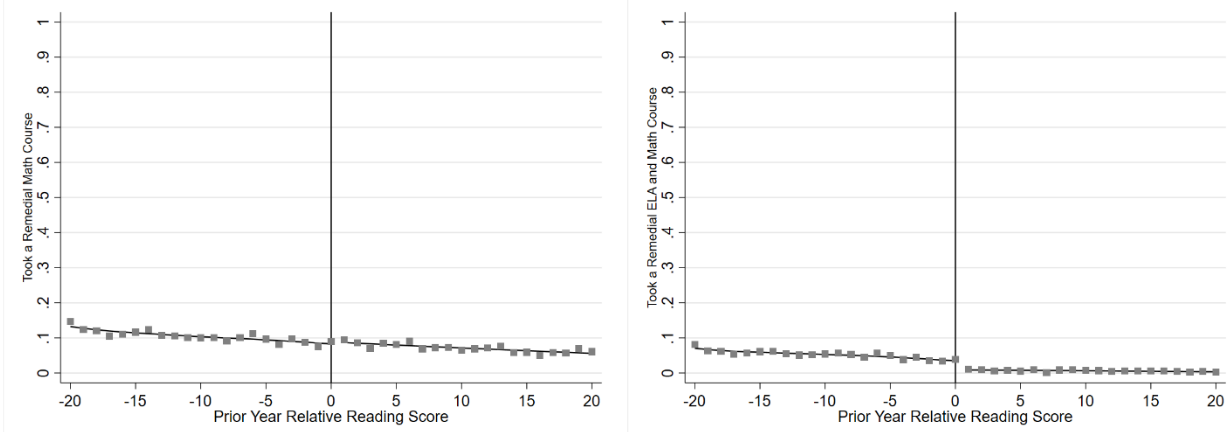


(F) Average Peer FRPL Eligibility in ELA Courses



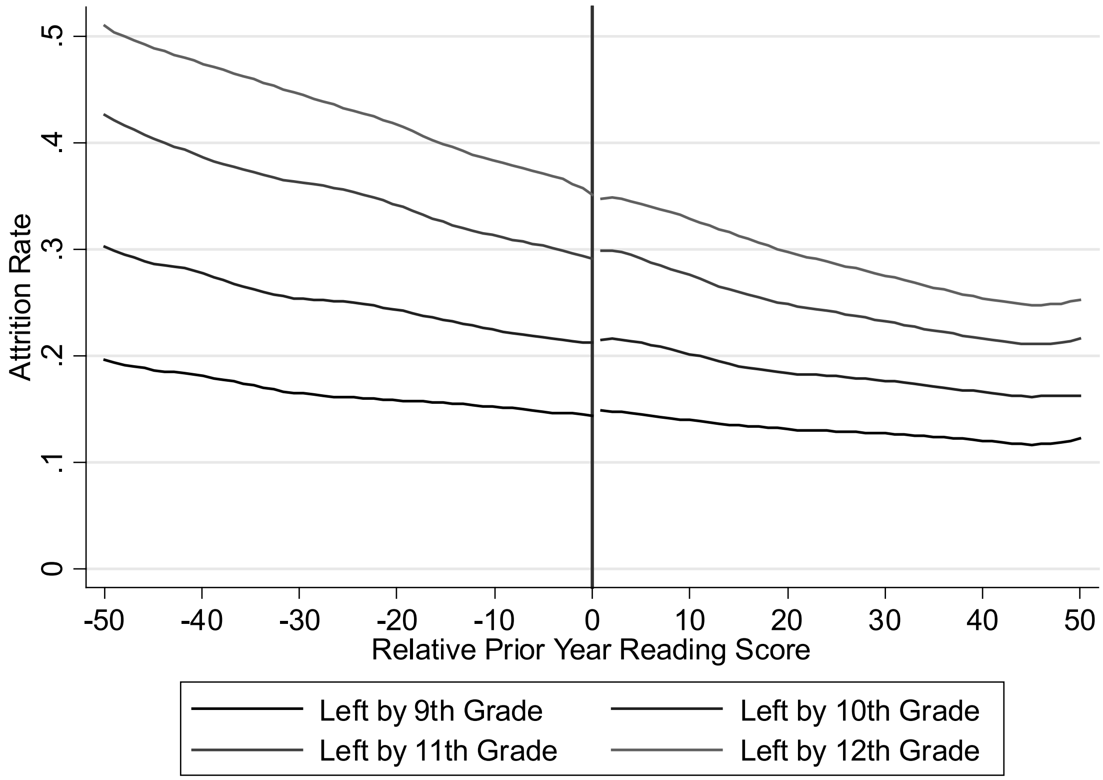
(G) Took a Remedial Math Course

(H) Took Both Remedial ELA and Math Course



Notes: The figure presents the raw cell means of the corresponding dependent variable for each reading score between 20 points below and above the retention cutoff. The solid lines represent the local linear smoothing of the treatment variable separately for the left of the cutoff date and the right. The triangle kernel and a bandwidth of 10 points are used in the estimation.

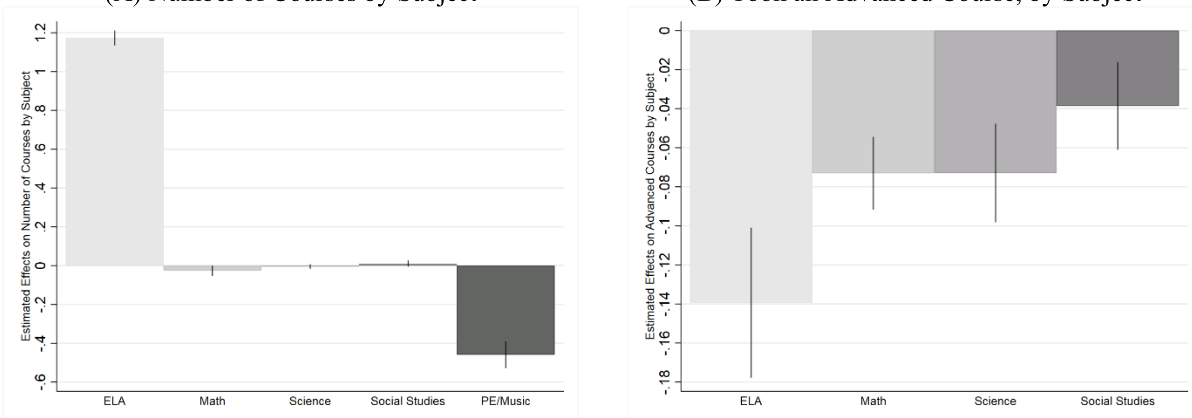
Figure 2. Sample Attrition Around the Remediation Cutoff



Notes: The figure present the local linear smoothing of the attrition rate in the following years separately for the left of the cutoff date and the right using a bandwidth of 10 points.

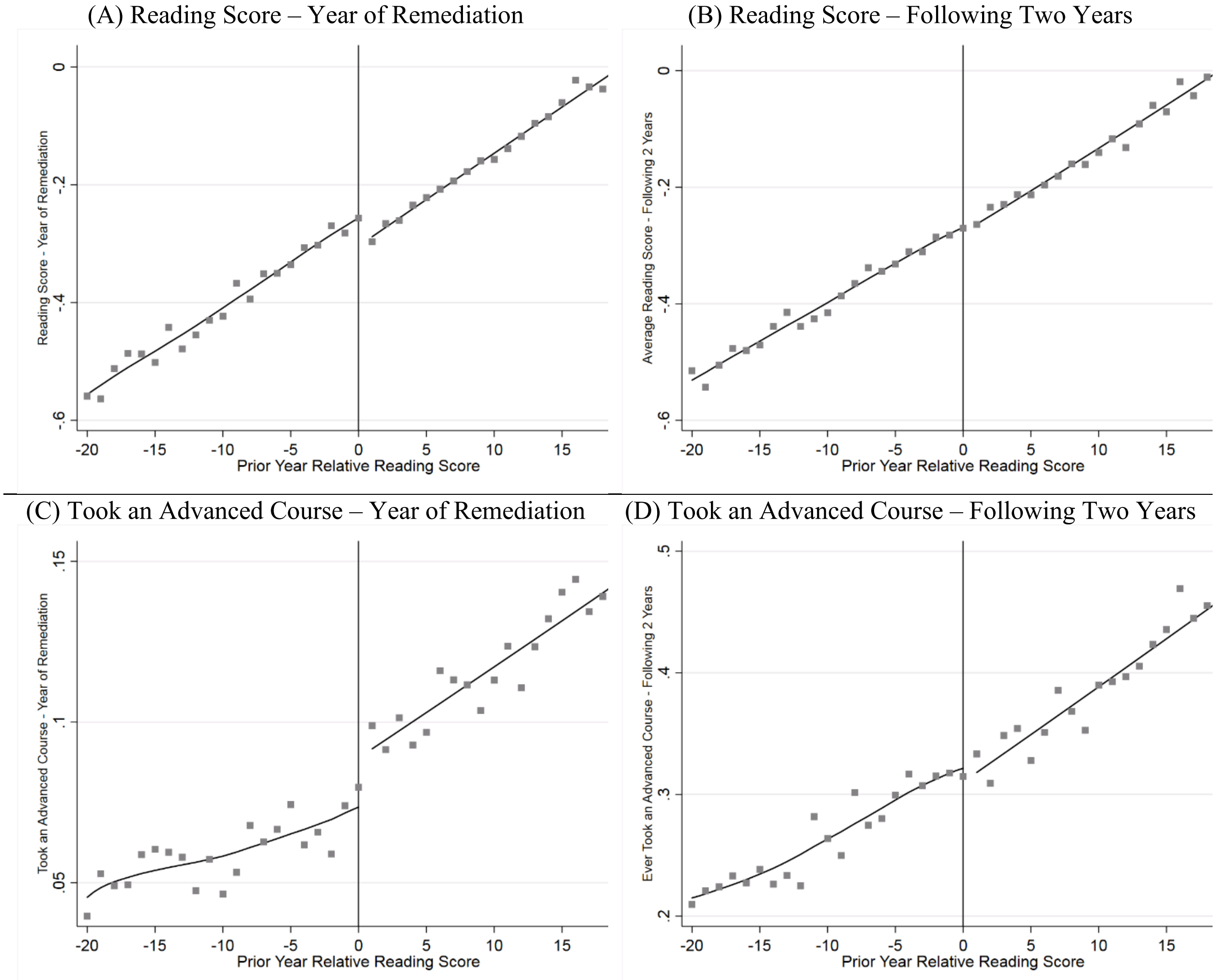
Figure 3. Effects of Taking a Remedial ELA Course on Course-Taking, Year of Remediation

(A) Number of Courses by Subject (B) Took an Advanced Course, by Subject



Notes: Bars in each figure represent the effect of taking a remediation ELA course on the corresponding outcome estimated using the 2SLS framework in equations (1) and (2) with a bandwidth of 10 points around the cutoff. Spikes in each figure provide the 95% confidence interval for the corresponding estimate. All regressions control for the baseline student characteristics listed in Table 2, and standard errors are clustered at the prior year reading score levels.

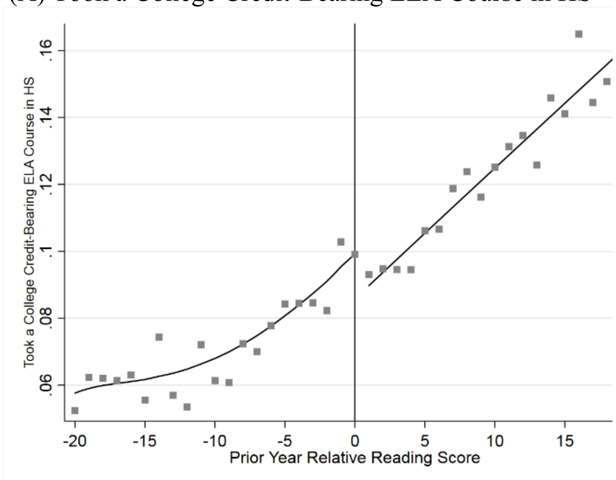
Figure 4. Reading Scores and Advanced Course-Taking Around the Remediation Cutoff, First Three Year



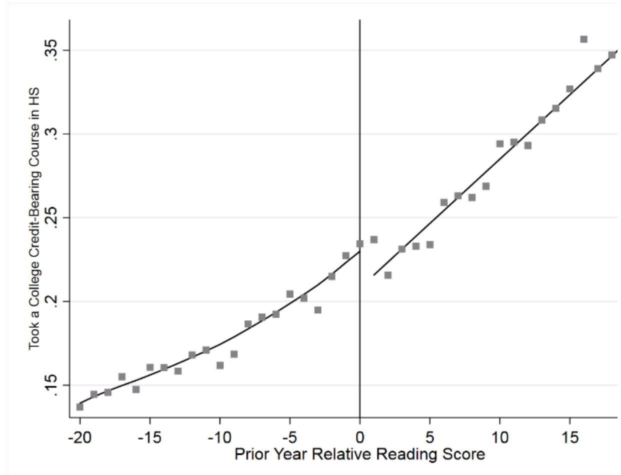
Notes: The figure presents the raw cell means of the corresponding dependent variable for each reading score between 20 points below and above the retention cutoff. The solid lines represent the local linear smoothing of the treatment variable separately for the left of the cutoff date and the right. The triangle kernel and a bandwidth of 10 points are used in the estimation.

Figure 5. High School Course-Taking and Postsecondary Outcomes Around the Remediation Cutoff

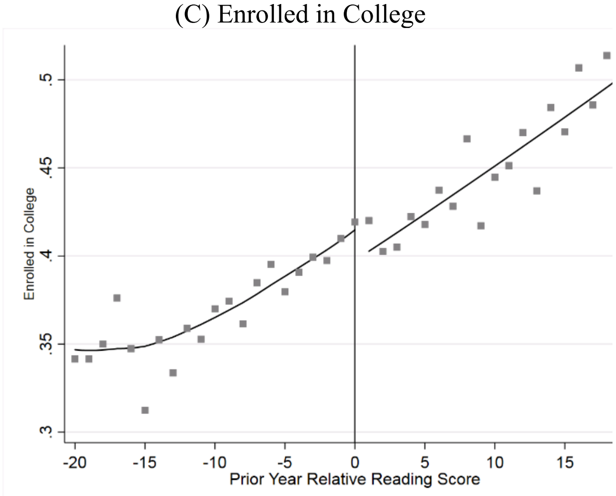
(A) Took a College Credit-Bearing ELA Course in HS



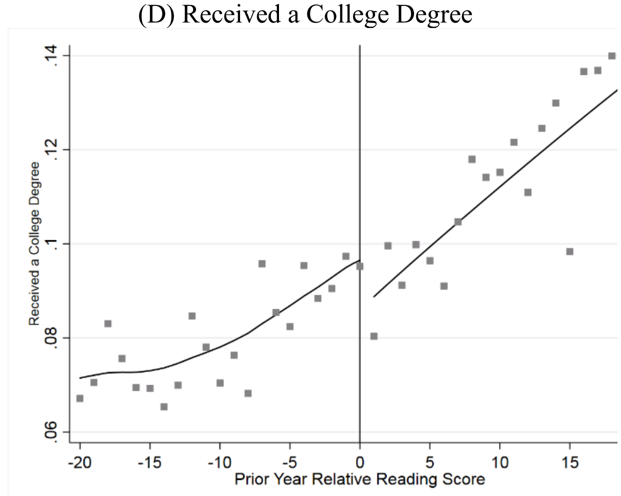
(B) Took a College Credit-Bearing Course in HS



(C) Enrolled in College



(D) Received a College Degree



Notes: The figure presents the raw cell means of the corresponding dependent variable for each reading score between 20 points below and above the retention cutoff. The solid lines represent the local linear smoothing of the treatment variable separately for the left of the cutoff date and the right. The triangle kernel and a bandwidth of 10 points are used in the estimation.

Appendix Table 1. Student Baseline Characteristics: Overall, by Prior Year ELA Score, and Attrition Status

	All students	10 points around the cutoff	Stayed until 12th grade	Left LUSD public schools before 12th grade
Prior year reading score	0.022	-0.280	0.188	-0.336
	(0.991)	(0.133)	(0.931)	(1.021)
Prior year math score	0.0267	-0.214	0.210	-0.370
	(0.987)	(0.620)	(0.905)	(1.038)
Prior year disciplinary incident	0.235	0.290	0.175	0.338
	(0.424)	(0.454)	(0.380)	(0.473)
Prior year % absent days	0.049	0.0491	0.0378	0.0691
	(0.058)	(0.0504)	(0.0389)	(0.0773)
FRPL eligible	0.578	0.696	0.527	0.653
	(0.494)	(0.460)	(0.499)	(0.476)
White	0.332	0.245	0.344	0.314
	(0.471)	(0.430)	(0.475)	(0.464)
Black	0.272	0.340	0.259	0.292
	(0.445)	(0.474)	(0.438)	(0.455)
Hispanic	0.327	0.360	0.315	0.345
	(0.469)	(0.480)	(0.464)	(0.475)
Male	0.516	0.503	0.490	0.556
	(0.500)	(0.500)	(0.500)	(0.497)
English non-native	0.418	0.370	0.336	0.541
	(0.493)	(0.483)	(0.472)	(0.498)
N	308,193	29,876	185,374	122,819

Notes: Standard deviations are given in parentheses. Reading and math scores are standardized at the grade-year level to zero mean and unit variance.

Appendix Table 2. Estimated Effects of Taking a Remedial ELA Course on Educational Inputs in the Year of Remediation

Instructional time in ELA courses	295.182***
	(8.243)
	[324.52]
Average class size in ELA courses	-2.530***
	(0.112)
	[19.75]
Average teacher VA score in ELA courses	0.012***
	(0.002)
Average peer achievement in ELA courses	-0.565***
	(0.017)
Average peer FRPL eligibility in ELA courses	0.086***
	(0.016)
	[0.645]
N	23,225

Notes: This table reports 2SLS estimates of the impact of taking a remedial ELA course on educational inputs during the year of remediation using equations (1) and (2). Robust standard errors, clustered at the prior year reading score level, are given in parentheses. The estimates represent the treatment effect (β) on the corresponding outcome obtained using linear polynomial specification and a bandwidth of 10 points. The numbers in brackets represent the predicted control mean at the cutoff. *, **, and *** represent statistical significance at 10, 5, and 1 percent, respectively.

Appendix Table 3. Robustness of Main Findings to Different Estimation Strategies and Samples

	Parametric: All Students	Non-parametric: All Students	Parametric: Stayed until 12th grade	Non-parametric: Stayed until 12th grade
Reading score – First 3 Years	0.047***	0.052***	0.056***	0.062***
	(0.015)	(0.013)	(0.018)	(0.016)
		[BW=13]		[BW=15]
College credit-bearing course in...				
ELA/Social studies	0.044**	0.037**	0.053***	0.039**
	(0.018)	(0.016)	(0.020)	(0.019)
		[BW=17]		[BW=15]
Overall	0.049**	0.045**	0.062***	0.052**
	(0.021)	(0.019)	(0.023)	(0.022)
		[BW=17]		[BW=14]
Enrolled in…				
College	0.028**	0.033***	0.025*	0.034**
	(0.013)	(0.011)	(0.015)	(0.014)
		[BW=20]		[BW=16]
“Very competitive” college	0.047**	0.038**	0.057*	0.050*
	(0.022)	(0.019)	(0.034)	(0.030)
		[BW=18]		[BW=16]
Enrolled beyond first year	0.047***	0.042***	0.054**	0.056***
	(0.017)	(0.013)	(0.025)	(0.019)
		[BW=19]		[BW=16]
Enrolled beyond second year	0.048***	0.027*	0.053**	0.038*
	(0.014)	(0.015)	(0.024)	(0.021)
		[BW=20]		[BW=17]
Received college degree	0.039***	0.022***	0.048***	0.035**
	(0.010)	(0.009)	(0.018)	(0.017)
		[BW=23]		[BW=19]

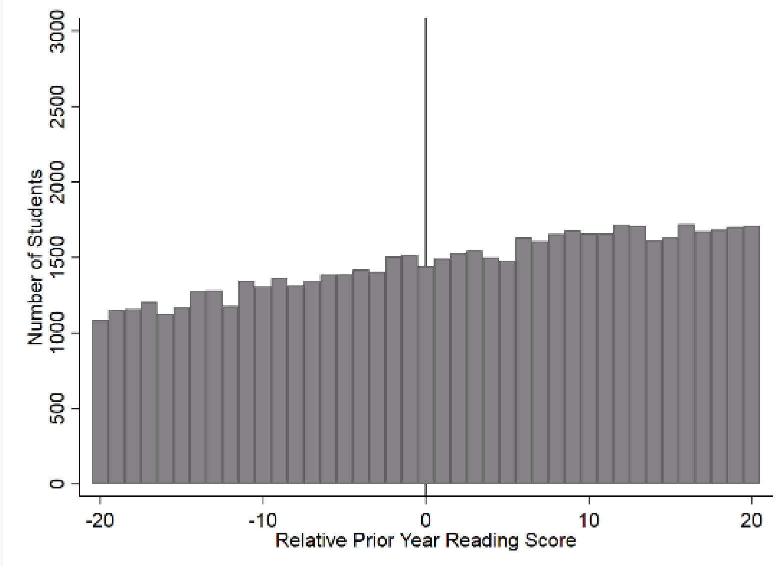
Notes: All regressions control for the baseline student characteristics listed in Table 2, and robust standard errors, clustered at the prior year reading score level, are given in parentheses. The parametric estimates represent the treatment effect (β) on the corresponding outcome obtained using linear polynomial specification and a bandwidth of 10 points. The numbers in brackets optimal bandwidth calculated using the algorithm developed by Calonico et al. (2017). *, **, and *** represent statistical significance at 10, 5, and 1 percent, respectively.

Appendix Table 4. Estimated Effects of Scoring Below the Remediation Cutoff on High School and Postsecondary Outcomes

High School Outcomes	
Took a college credit-bearing course in…	
ELA	0.015***
	(0.005)
	[0.092]
Math	0.001
	(0.004)
	[0.048]
Science	0.004
	(0.006)
	[0.076]
Social Studies	0.016**
	(0.007)
	[0.181]
Overall	0.021**
	(0.009)
	[0.222]
Received a standard HS diploma	0.011
	(0.011)
	[0.552]
N	28,157
Postsecondary Outcomes	
Enrolled in college	0.012**
	(0.006)
	[0.418]
Enrolled in "very competitive" college	0.021**
	(0.010)
	[0.095]
Enrolled beyond first year	0.020***
	(0.007)
	[0.310]
Enrolled beyond second year	0.021***
	(0.006)
	[0.220]
Years in college	0.083***
	(0.018)
	[1.160]
Received a degree	0.016***
	(0.005)
	[0.086]
N	22,085

Notes: This table reports estimates of scoring below the remediation cutoff on student outcomes. All regressions control for the baseline student characteristics listed in Table 2, and robust standard errors, clustered at the prior year reading score level, are given in parentheses. The estimates represent the reduced-form estimates on the corresponding outcome obtained using linear polynomial specification and a bandwidth of 10 points. The numbers in brackets represent the predicted control mean at the cutoff. *, **, and *** represent statistical significance at 10, 5, and 1 percent, respectively.

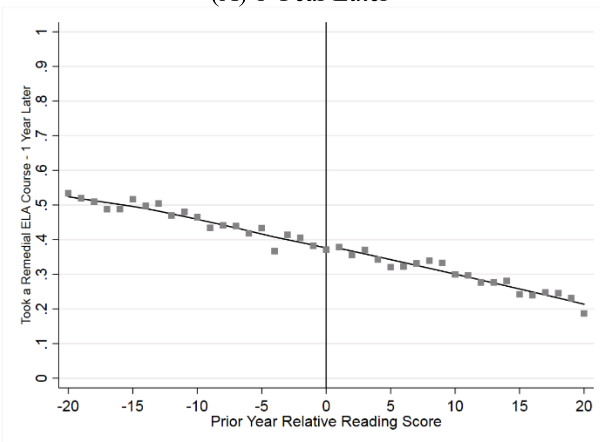
Appendix Figure 1. Distribution of Prior Year Reading Scores



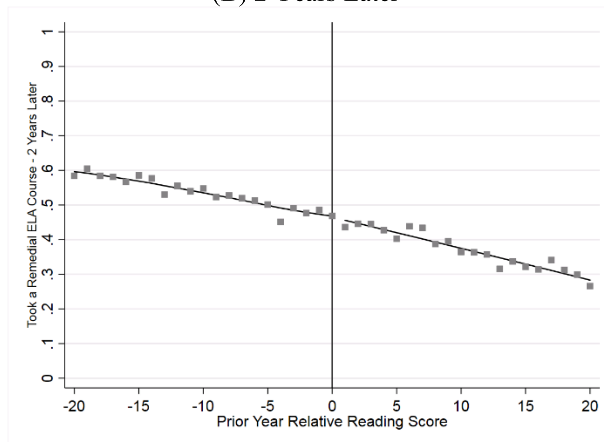
Notes: The figure presents the number of students in each reading score bin between 20 points below and above the remediation cutoff, which is shown by the vertical line.

Appendix Figure 2. The Likelihood of Taking a Remedial ELA Course in the Following Years around the Remediation Cutoff

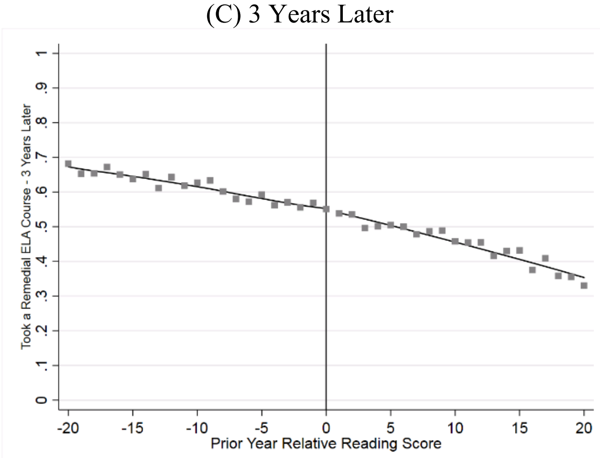
(A) 1 Year Later



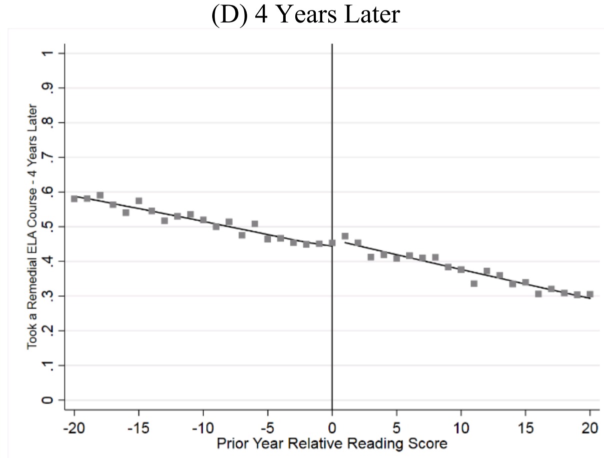
(B) 2 Years Later



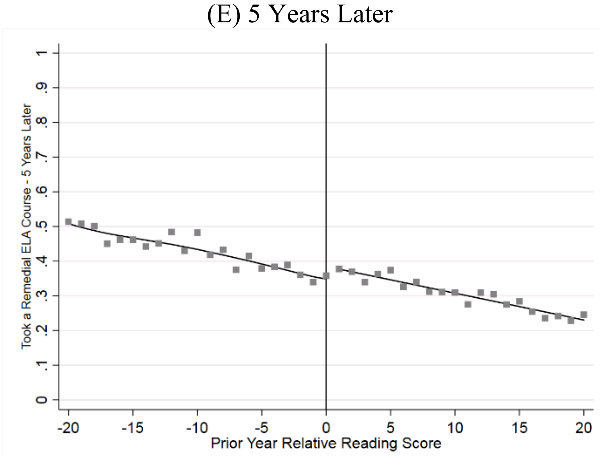
(C) 3 Years Later



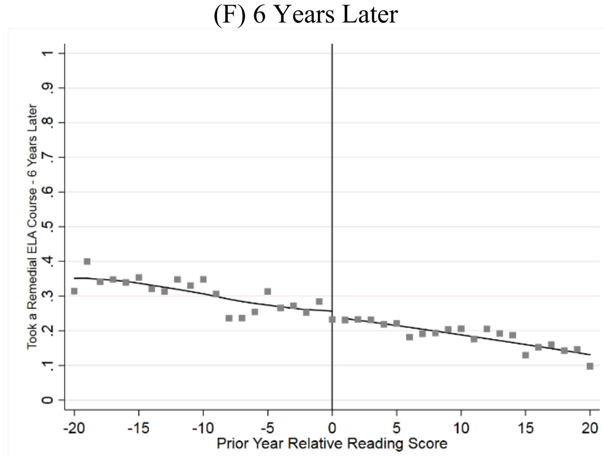
(D) 4 Years Later



(E) 5 Years Later



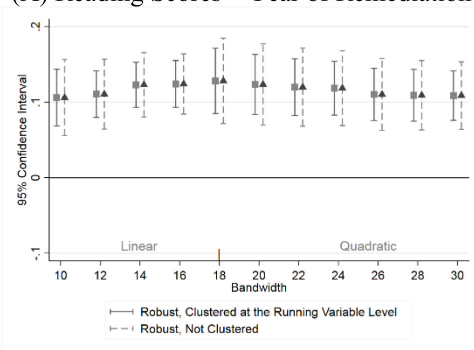
(F) 6 Years Later



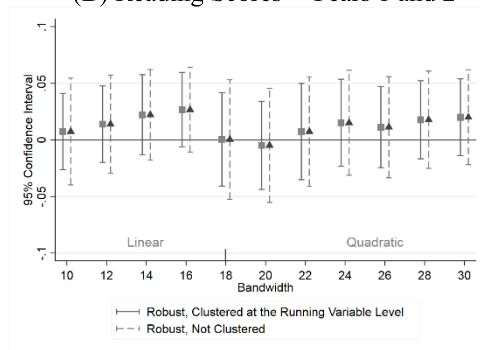
Notes: The figure presents the raw cell means of the corresponding dependent variable for each reading score between 20 points below and above the retention cutoff. The solid lines represent the local linear smoothing of the treatment variable separately for the left of the cutoff date and the right. The triangle kernel and a bandwidth of 10 points are used in the estimation.

Appendix Figure 3. Robustness to Bandwidth Selection and Standard Error Clustering

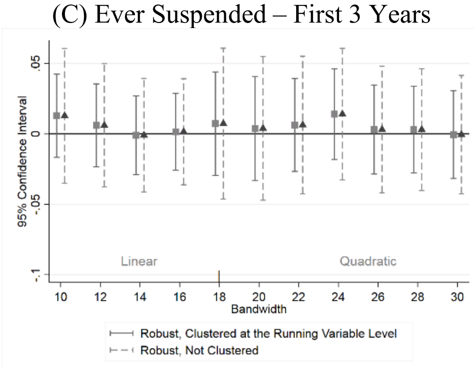
(A) Reading Scores – Year of Remediation



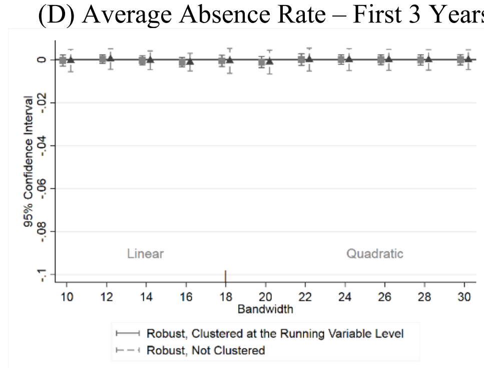
(B) Reading Scores – Years 1 and 2



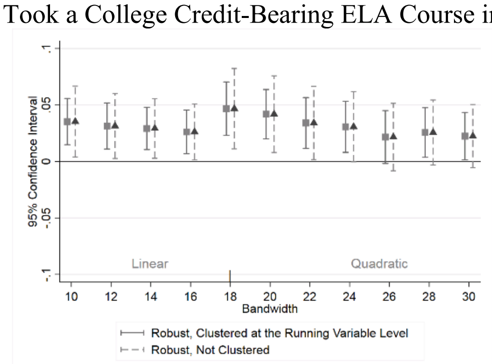
(C) Ever Suspended – First 3 Years



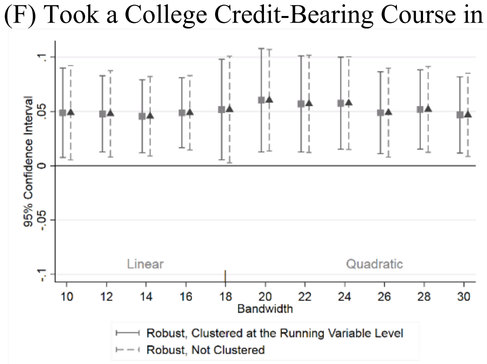
(D) Average Absence Rate – First 3 Years



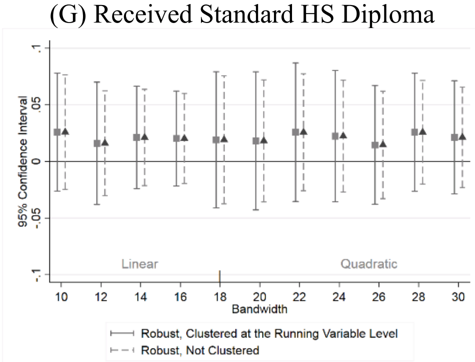
(E) Took a College Credit-Bearing ELA Course in HS



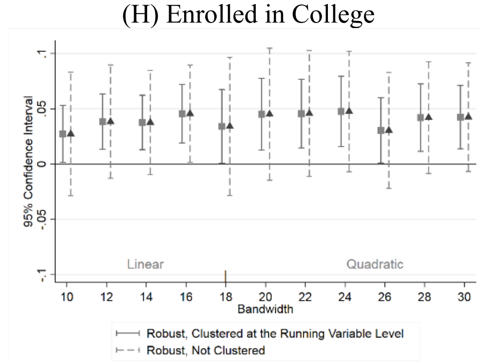
(F) Took a College Credit-Bearing Course in HS



(G) Received Standard HS Diploma

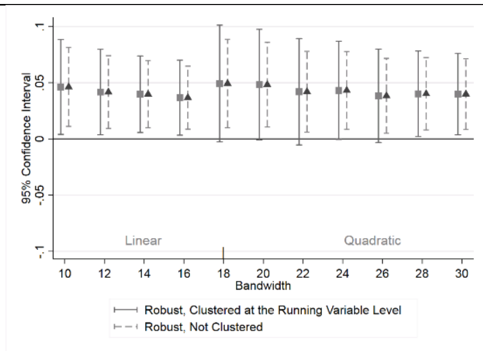


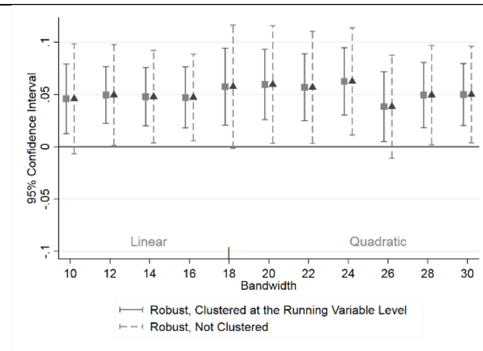
(H) Enrolled in College



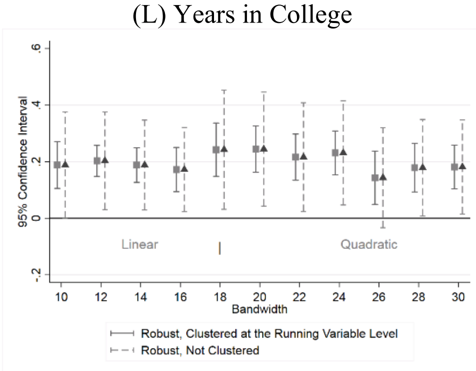
(J) Enrolled in "Very Competitive" College

(K) Enrolled Beyond First Year

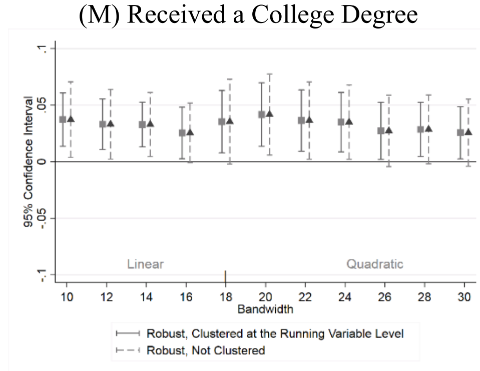




(L) Years in College



(M) Received a College Degree



Notes: The figures present 2SLS estimates and the 95% confidence interval estimated using the bandwidth shown and polynomial specification, with robust standard errors clustered at the prior year reading score level (solid line) and not clustered (dashed line). All regressions control for the baseline student characteristics listed in Table 2.

Online Appendix

Heterogeneous Treatment Effects

Do certain student groups benefit more from the remediation policy compared to others? While I do not have sufficient power to statistically distinguish the estimated effects across different subgroups in many cases, in this section I examine the heterogeneous treatment effects on outcomes of interest by grade of remediation and student attributes respectively. The findings presented in Online Appendix Table 1 provide suggestive evidence that remedial ELA courses are more beneficial in later grades, especially in 8^{th} grade. Taking a remedial ELA course in 8^{th} grade increases the likelihood of taking a college credit-bearing course in high school by nearly 6.3 percentage points (or 30 percent), college enrollment by 12 percentage points (25 percent), and degree attainment by 7 percentage points (or 70 percent). The estimated effects for other grades, in many cases, are smaller in magnitude and statistically indistinguishable from zero.

There are several mechanisms that could drive the differential effects by grade of remediation. One possibility is dynamic treatment assignment whereby remediation in earlier grades leads to a smaller difference (compared to remediation in later grades) in the likelihood of "ever receiving treatment before the outcome of interest is observed" at the cutoff. That is, the positive test score effects of remediation could reduce future remediation for students below the cutoff (compared to those above), and this reduction could be larger by the time the outcome is observed when remediation takes place in earlier grades, simply because there is more time between remediation and outcome. If this is the case, one would underestimate the true benefit of remediation in earlier grades. The last column in Online Appendix Table 1 examines this possibility for high school and postsecondary outcomes and presents the estimated discontinuities in the likelihood of "ever being placed in the remedial ELA schedule" after the grade of remediation provided in each column until the end of 12th grade. The results reveal no significant discontinuity at the remediation cutoff, providing evidence against this possibility.

Second, the benefits of remedial courses could be larger conditional on having taken a remedial course in prior grades. This could arise, for example, due to dynamic complementarities (e.g., Johnson and Jackson 2019) or if being identified for remediation more than once sends a stronger signal to students and/or parents. Using the sample of 8th graders, I examine this possibility and break down the analysis by whether the student took at least one remedial ELA course in 6th or 7th grade. The results, reported in Online Appendix Table 2, provide suggestive evidence supporting this hypothesis with larger benefits (especially in the long-run) conditional on having taken at least one remedial ELA course in 6th or 7th grades, yet the estimated coefficients are statistically indistinguishable in many cases due to sample size issues. For example, conditional on prior remediation, taking a remedial ELA course in 8th grade increases the likelihood of taking a college credit-bearing course in high school by nearly 7.6 percentage points (or 45 percent), college enrollment by 14 percentage points (38 percent), and persistence beyond the second year by 12 percentage points (or by 50 percent). In contrast, the effects on 8th graders taking a remedial ELA course for the first time is -0.1 percentage points (less than 1 percent of the control mean at the cutoff) for advanced course-taking in high school, 5 percentage points (or 10 percent) for college enrollment, and -1 percentage point (or 3 percent) for persistence beyond second year.[1]

[1] It is important to keep in mind that these two student groups differ considerably along 5th grade characteristics including test scores, racial composition, and socioeconomic status, which could drive the differences in treatment effects rather than alternative explanations such as dynamic complementarities. For example, 8th graders who take a remedial ELA course for the first time have significantly higher 5th grade test scores, are significantly less likely to belong to a racial minority group, and less likely to be eligible for subsidized meals. That said, the findings presented in Online Appendix Table 3 do not reveal any obvious heterogeneity in treatment effects by race/ethnicity or SES and suggest that the effects are larger for students who were higher-performing on prior year math tests, which is contrary to what one would expect if the differences in baseline characteristics was the main driver behind the heterogeneity by prior remediation.

Online Appendix Table 3 breaks down the analysis by student attributes such as race/ethnicity, gender, native language, FRPL eligibility, and extant human capital as proxied by prior year math scores. The most striking finding in this table is the differential effect of remedial courses by gender and extant human capital, with girls and students with higher prior year math achievement benefiting significantly more. Specifically, for girls, taking a remedial ELA course increases college enrollment by 5 percentage points (or more than 10 percent), "very competitive" college enrollment by 8 percentage points (80 percent), enrollment beyond first year by 7.5 percentage points (20 percent), and degree attainment by 4.5 percentage points (45 percent). In contrast, for boys, the results reveal zero effect on college enrollment, an effect of 1 percentage point (10 percent) on selective college enrollment, 1.3 percentage points (5 percent) on enrollment beyond first year, and 2.8 percentage points (or 35 percent) on degree attainment, with only the last estimate being statistically significant at conventional levels. Similarly, taking a remedial ELA course in middle school is more beneficial for students who were proficient on prior year math tests.

Online Appendix Table 4 breaks down this exercise further and examines the differential effects by gender based on prior math achievement. The results suggest that the positive effects observed in Tables 3 and 4 are mostly driven by the effects of the policy on higher-performing girls. Specifically, among higher-performing girls, taking a remedial ELA course in middle school increases the average reading scores in the first three years by 0.11σ, nearly doubles the likelihood of taking a college credit-bearing course in ELA, increases this likelihood by 12 percentage points (30 percent) in social studies, increases the likelihood of enrolling in college by 17 percentage points (roughly 30 percent), nearly doubles the likelihood of enrolling in a "very competitive" college, increases persistence beyond first and second years by 18 and 15 percentage points (30 and 50 percent respectively), and degree attainment by 9.5 percentage points (50 percent). All these effects are statistically different than zero at 10 percent or higher. Further, all estimated effects on postsecondary outcomes for higher-performing girls are statistically distinguishable from the estimated coefficients for males or students who were not proficient on prior year math test at 10 percent level or higher. Given that girls are more likely to pursue careers in fields that require higher competency in ELA and social studies (e.g., English Language and Literature, Journalism, Communication), these findings seem to suggest that ELA remediation in middle school helps these students succeed in college by helping them acquire higher human capital in ELA and social studies in middle and high school.

Online Appendix Table 1. Estimated Effects of Taking a Remedial ELA Course, by Grade of Remediation

	Grade of remediation		
	6th grade	7th grade	8th grade
Reading scores			
Year of remediation	0.068**	0.121***	0.132***
	(0.032)	(0.035)	(0.034)
p-value (equality of coefficients)		0.318	0.123
Following 2 years	-0.087**	0.065***	0.040
	(0.037)	(0.024)	(0.032)
p-value (equality of coefficients)		0.000	0.013
Took college credit-bearing course in…			
ELA/Social Studies	0.023	0.041	0.061**
	(0.047)	(0.039)	(0.030)
	[0.199]	[0.211]	[0.197]
p-value (equality of coefficients)		0.811	0.350
Math/Science	0.007	0.010	0.012
	(0.027)	(0.034)	(0.013)
	[0.098]	[0.097]	[0.096]
p-value (equality of coefficients)		0.940	0.862
Overall	0.039	0.038	0.063**
	(0.043)	(0.042)	(0.029)
	[0.221]	[0.230]	[0.217]
p-value (equality of coefficients)		0.996	0.438
Enrolled in college	-0.042	-0.006	0.118***
	(0.055)	(0.035)	(0.036)
	[0.383]	[0.445]	[0.422]
p-value (equality of coefficients)		0.664	0.026
Enrolled in "very competitive" college	0.039***	0.045	0.051
	(0.013)	(0.038)	(0.040)
	[0.073]	[0.105]	[0.108]
p-value (equality of coefficients)		0.862	0.786
Enrolled beyond first year	0.003	0.025	0.100**
	(0.035)	(0.033)	(0.043)
	[0.278]	[0.322]	[0.331]
p-value (equality of coefficients)		0.683	0.098
Enrolled beyond second year	0.010	0.053*	0.069*
	(0.022)	(0.032)	(0.039)
	[0.183]	[0.215]	[0.267]
p-value (equality of coefficients)		0.271	0.261
Years in college	-0.018	0.169	0.364**
	(0.132)	(0.118)	(0.146)
	[1.028]	[1.195]	[1.258]
p-value (equality of coefficients)		0.341	0.103
Received a degree	0.035	0.016	0.072*
	(0.031)	(0.048)	(0.042)
	[0.061]	[0.090]	[0.108]
p-value (equality of coefficients)		0.786	0.869
Ever took a remedial course until 12th grade	-0.010	-0.005	-0.004
	(0.015)	(0.036)	(0.037)
	[0.889]	[0.839]	[0.776]

p-value (equality of coefficients)	0.923	0.874

Notes: This table reports 2SLS estimates of the impact of taking a remedial ELA course on student outcomes using equations (1) and (2) broken down by grade. All regressions control for the baseline student characteristics listed in Table 2, and robust standard errors, clustered at the prior year reading score level, are given in parentheses. The estimates represent the treatment effect (β) on the corresponding outcome obtained using linear polynomial specification and a bandwidth of 10 points. The reported p-values come from tests of equality of coefficients for 7th and 8th grade regressions compared to the coefficients obtained for 6th grade. The numbers in brackets represent the predicted control mean at the cutoff. *, **, and *** represent statistical significance at 10, 5, and 1 percent, respectively.

Online Appendix Table 2. Estimated Effects of Taking a Remedial ELA Course in 8th Grade, by Prior Remediation

	Did not take a remedial ELA course in 6th or 7th grade	Took a remedial ELA course in 6th or 7th grade
Reading scores		
Year of remediation	0.195***	0.123***
	(0.064)	(0.039)
p-value (equality of coefficients)		0.094
Following 2 years	0.079*	0.046
	(0.045)	(0.046)
p-value (equality of coefficients)		0.197
Took college credit-bearing course in…		
ELA/Social Studies	-0.015	0.084**
	(0.034)	(0.033)
	[0.256]	[0.151]
p-value (equality of coefficients)		0.288
Math/Science	-0.045	0.042*
	(0.034)	(0.024)
	[0.138]	[0.062]
p-value (equality of coefficients)		0.275
Overall	-0.001	0.076**
	(0.028)	(0.033)
	[0.276]	[0.170]
p-value (equality of coefficients)		0.446
Enrolled in college	0.048	0.142***
	(0.057)	(0.045)
	[0.472]	[0.369]
p-value (equality of coefficients)		0.305
Enrolled in "very competitive" college	0.054	0.053
	(0.058)	(0.035)
	[0.135]	[0.086]
p-value (equality of coefficients)		0.563
Enrolled beyond first year	0.026	0.157***
	(0.065)	(0.043)
	[0.388]	[0.267]
p-value (equality of coefficients)		0.255
Enrolled beyond second year	-0.010	0.118***
	(0.056)	(0.038)
	[0.307]	[0.223]
p-value (equality of coefficients)		0.144
Years in college	0.045	0.590***
	(0.196)	(0.166)
	[1.428]	[1.054]
p-value (equality of coefficients)		0.164
Received a degree	0.048	0.058*
	(0.057)	(0.031)
	[0.122]	[0.088]
p-value (equality of coefficients)		0.814

Notes: This table reports 2SLS estimates of the impact of taking a remedial ELA course in 8th grade on student outcomes using equations (1) and (2) broken down by prior remedial course-taking. Robust standard errors, clustered at the prior year reading score level, are given in parentheses. The estimates represent the discontinuities in student characteristics at the remediation cutoff, obtained using linear polynomial specification and a bandwidth of

10 points. The reported p-values come from tests of equality of coefficients presented in the third column compared to the coefficients in the second column. The numbers in brackets represent the predicted control mean at the cutoff. *, **, and *** represent statistical significance at 10, 5, and 1 percent, respectively.

Online Appendix Table 3. Estimated Effects of Taking a Remedial ELA Course, by Student Attributes

	Reading scores: First 3 Years	College credit-bearing course in HS	Enrolled in college	Enrolled in very competitive college	Enrolled beyond first year	Received a degree
White	0.139***	0.051	0.030	0.061*	0.042	0.028*
	(0.038)	(0.043)	(0.040)	(0.033)	(0.029)	(0.017)
		[0.221]	[0.394]	[0.111]	[0.308]	[0.102]
Black	0.020	0.096***	0.034	0.041	0.077***	0.041
	(0.034)	(0.034)	(0.037)	(0.046)	(0.028)	(0.033)
		[0.205]	[0.431]	[0.101]	[0.306]	[0.068]
p-value (equality of coefficients)	0.112	0.506	0.929	0.638	0.478	0.948
Hispanic	0.020	-0.027	-0.002	0.023*	0.007	0.017
	(0.041)	(0.035)	(0.045)	(0.014)	(0.035)	(0.029)
		[0.218]	[0.404]	[0.068]	[0.293]	[0.081]
p-value (equality of coefficients)	0.205	0.018	0.468	0.338	0.583	0.658
Male	0.040	0.033*	0.000	0.010	0.013	0.028*
	(0.031)	(0.018)	(0.026)	(0.018)	(0.025)	(0.016)
		[0.190]	[0.388]	[0.079]	[0.273]	[0.064]
Female	0.052***	0.060*	0.051**	0.081***	0.075***	0.045***
	(0.015)	(0.034)	(0.020)	(0.031)	(0.027)	(0.016)
		[0.252]	[0.446]	[0.110]	[0.345]	[0.104]
p-value (equality of coefficients)	0.668	0.404	0.168	0.011	0.117	0.426
English non-native	0.069	0.018	-0.025	0.060***	-0.001	0.020
	(0.044)	(0.026)	(0.037)	(0.021)	(0.036)	(0.023)
		[0.231]	[0.430]	[0.091]	[0.330]	[0.098]
English native	0.038***	0.064*	0.054*	0.039	0.069***	0.044***
	(0.015)	(0.036)	(0.029)	(0.024)	(0.022)	(0.010)
		[0.216]	[0.410]	[0.097]	[0.297]	[0.078]
p-value (equality of coefficients)	0.553	0.373	0.178	0.317	0.105	0.209
FRPL eligible	0.032*	0.060**	0.014	0.046**	0.036	0.016
	(0.017)	(0.028)	(0.025)	(0.023)	(0.031)	(0.017)
		[0.198]	[0.382]	[0.066]	[0.267]	[0.066]
FRPL ineligible	0.087***	0.011	0.051*	0.043	0.056	0.081***
	(0.018)	(0.021)	(0.030)	(0.051)	(0.041)	(0.025)
		[0.280]	[0.514]	[0.173]	[0.425]	[0.139]
p-value (equality of coefficients)	0.005	0.133	0.395	0.955	0.740	0.051
Not proficient on prior math	0.032	0.023	-0.011	0.020	0.009	0.002
	(0.025)	(0.019)	(0.024)	(0.017)	(0.029)	(0.012)
		[0.159]	[0.362]	[0.062]	[0.256]	[0.065]
Proficient on prior math	0.068***	0.073**	0.080***	0.075	0.092***	0.084***
	(0.026)	(0.036)	(0.023)	(0.048)	(0.033)	(0.021)
		[0.314]	[0.502]	[0.146]	[0.392]	[0.120]

p-value (equality of coefficients)	0.403	0.203	0.031	0.278	0.127	0.000

Notes: This table reports 2SLS estimates of the impact of taking a remedial ELA course in 8th grade on student outcomes using equations (1) and (2) broken down by student attributes. All regressions control for the baseline student characteristics listed in Table 2, and robust standard errors, clustered at the prior year reading score level, are given in parentheses. The estimates represent the treatment effect (β) on the corresponding outcome obtained using linear polynomial specification and a bandwidth of 10 points. The reported p-values come from tests of equality of coefficients for the given student group compared to the coefficients for the baseline category (White, male, English non-native, FRPL eligible, not proficient on prior year math tests). The numbers in brackets represent the predicted control mean at the cutoff. *, **, and *** represent statistical significance at 10, 5, and 1 percent, respectively.

Online Appendix Table 4. Estimated Effects of Taking a Remedial ELA Course, by Gender and Prior Math Achievement

	Not Proficient on Prior Year Math Test		Proficient on Prior Year Math Test		Male or Not Proficient
	Male	Female	Male	Female	
Reading score – First 3 Years	0.047	0.015	0.036	0.113**	0.031
	(0.038)	(0.028)	(0.038)	(0.051)	(0.022)
p-value (equality of coefficients)		0.476		0.287	0.085
Took college credit-bearing course in...					
ELA	0.004	0.060***	-0.061**	0.133***	0.009
	(0.022)	(0.023)	(0.027)	(0.035)	(0.014)
	[0.047]	[0.074]	[0.109]	[0.164]	[0.076]
p-value (equality of coefficients)		0.089		0.000	0.000
Math/Science	0.008	0.038*	-0.018	-0.020	0.015
	(0.020)	(0.021)	(0.034)	(0.037)	(0.012)
	[0.044]	[0.050]	[0.150]	[0.189]	[0.076]
p-value (equality of coefficients)		0.077		0.332	0.650
Social studies	0.015	-0.022	0.054*	0.115**	0.014
	(0.026)	(0.022)	(0.032)	(0.056)	(0.017)
	[0.087]	[0.161]	[0.213]	[0.309]	[0.153]
p-value (equality of coefficients)		0.038		0.355	0.000
Overall	0.021	0.018	0.038	0.115*	0.028*
	(0.030)	(0.024)	(0.034)	(0.064)	(0.017)
	[0.117]	[0.190]	[0.268]	[0.369]	[0.190]
p-value (equality of coefficients)		0.963		0.218	0.001
Enrolled in college	-0.011	-0.021	0.004	0.173***	-0.008
	(0.037)	(0.031)	(0.033)	(0.041)	(0.019)
	[0.324]	[0.391]	[0.465]	[0.544]	[0.390]
p-value (equality of coefficients)		0.766		0.003	0.000
Enrolled in “very competitive” college	0.003	0.033	0.008	0.155***	0.019
	(0.019)	(0.027)	(0.044)	(0.059)	(0.019)
	[0.047]	[0.073]	[0.118]	[0.177]	[0.077]
p-value (equality of coefficients)		0.382		0.001	0.000
Enrolled beyond first year	-0.000	0.010	0.019	0.183***	0.013
	(0.039)	(0.037)	(0.051)	(0.048)	(0.021)
	[0.212]	[0.289]	[0.348]	[0.444]	[0.279]
p-value (equality of coefficients)		0.961		0.023	0.000
Enrolled beyond second year	0.021	0.028	-0.015	0.154***	0.021
	(0.030)	(0.032)	(0.043)	(0.046)	(0.018)
	[0.139]	[0.207]	[0.246]	[0.330]	[0.194]
p-value (equality of coefficients)		0.937		0.007	0.000
Received college degree	-0.023*	0.020	0.082***	0.095***	0.024*
	(0.014)	(0.015)	(0.032)	(0.036)	(0.013)
	[0.051]	[0.075]	[0.085]	[0.160]	[0.069]
p-value (equality of coefficients)		0.044		0.767	0.017

Notes: This table reports 2SLS estimates of the impact of taking a remedial ELA course in 8th grade on student outcomes using equations (1) and (2) broken down by gender and prior math achievement. All regressions control for the baseline student characteristics listed in Table 2, and robust standard errors, clustered at the prior year reading score level, are given in parentheses. The estimates represent the treatment effect (β) on the corresponding outcome obtained using linear polynomial specification and a bandwidth of 10 points. The reported p-values come from tests of equality of coefficients presented in third, fifth, and sixth columns compared to the coefficients in the second, fourth, and fifth columns respectively. The numbers in brackets represent the predicted control mean at the cutoff. *, **, and *** represent statistical significance at 10, 5, and 1 percent, respectively.