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The Effects of High School Remediation on Long-Run Educational Attainment

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Abstract: This study examines the effects of remedial courses in high school on postsecondary outcomes using a regression discontinuity design and explores the mechanisms behind these effects. I find that being placed in the remedial schedule and taking an additional remedial course in high school reduces the likelihood of attaining a 2- or 4-year college degree by 20 percent. The findings also suggest that nearly half of this adverse effect is driven by the tracking effect of remediation, which significantly reduces students' access to advanced courses in high school not only in the remediation subject but also in other core subjects.

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

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1. Introduction

Improving college and career readiness for all students is a top priority in state and federal education policy in the United States[1], with many incoming college students deemed not ready for college-level coursework. Remedial courses are a common proposal to address student needs in many settings[2]; however, important questions remain about the effectiveness (and the unintended consequences) of this practice. For example, requiring underprepared students to take remedial courses in college before they can enroll in college-level courses (i.e., prerequisite remedial courses) have been shown to have little effect on postsecondary and labor market outcomes of students (e.g., Bettinger & Long, 2009; Boatman & Long, 2018; Martorell & McFarlin, 2011).[3] These courses may even be detrimental for the long-term well-being of these students given the financial burden they impose: Recent estimates suggest that college students nationwide pay roughly $1.3 billion in tuition annually for remedial courses that often do not count towards the completion of a degree (Jimenez et al, 2016).

In this study, I examine whether remedial courses in high school – a setting where remediation does not carry any financial burden for students – can serve as an effective lever to improve postsecondary outcomes and explore the mechanisms behind these effects. To identify the causal effects of remedial courses, I rely on a regression discontinuity (RD) design and leverage the non-linearity in the likelihood of remediation driven by a Florida policy that

[1] For example, 37 states and the District of Columbia currently incorporate college and career readiness measures into their school accountability systems as part of their school quality and student success indicator, which is a required component under the federal Every Student Succeeds Act (Erwin et al., 2021).
[2] Recent estimates suggest that 65% of community college students and nearly one-third of all students attending 4-year public colleges nationwide are required to take at least one remedial course when they enter college (Chen et al, 2020).
[3] In contrast, corequisite remedial courses that allow low-performing students to enroll in college-level courses while receiving remedial instruction have been shown to improve student outcomes in college (Jaggars et al., 2015; Logue et al., 2016; Miller et al., 2022; Ran and Lin, 2022).

requires high school students who score below the proficient level in the statewide English language arts (ELA) test to take a remedial course along with the regular course in ELA. These are important questions for a couple of reasons.

First, millions of high school students take remedial courses every year (nearly a quarter of high school students in Florida took a remedial ELA course in 2022-23 school year[4]), yet we know very little about their effects on postsecondary outcomes. Second, while similar approaches in middle school have been shown to improve short-term student outcomes (e.g., Taylor, 2014) and postsecondary outcomes (Özek, 2021)[5], it is not clear whether these findings apply to the high school setting for several reasons. For example, being placed in a remedial track could lead to student disengagement from schooling, which could lead to elevated dropout rates in high school (in contrast, most middle school students are not old enough to leave schooling legally), and hinder students' access to college credit-bearing courses that may improve college readiness and postsecondary outcomes.

Similarly, requiring low-performing students to take an additional remedial course without extending the school day could crowd out electives that are consequential for students in the long term such as Career and Technical Education (CTE) courses, which have been shown to improve labor market outcomes for some students (e.g., Brunner et al., 2023; Kreisman & Stange, 2020), and hinder their ability to pursue alternative career pathways. In fact, following the enactment of Florida's policy, this was a concern raised by high school principals in Florida who estimated that they eliminated hundreds of elective teacher positions (mostly in CTE

[4] Author's calculations from publicly-available course enrollment and student enrollment numbers from Florida Department of Education: https://www.fldoe.org/accountability/data-sys/edu-info-accountability-services/pk-12-public-school-data-pubs-reports/students.stml, accessed 12/27/23.
[5] In contrast, Dougherty (2015) finds significant negative effects (especially among students of color) of a policy that increased reading instruction time in sixth grade for lower-performing students.

courses) because too many high school students were taking remedial courses, especially in ELA.[6]

Using student-level administrative school records that are linked to National Student Clearinghouse (NSC) records from a large urban school district (LUSD) in Florida, I find significant adverse effects of remedial high school courses on postsecondary outcomes. In particular, taking a remedial high school course in 9th or 10th grade reduces the likelihood of enrolling in a 4-year institution by 5.4 percentage points (roughly equivalent to 9 percent of the comparison group mean at the remediation cutoff), ever enrolling in a "highly competitive" postsecondary institution by 6 percentage points (by 20 percent), and attaining a 2- or 4-year college degree by 6.2 percentage points (by 18 percent).[7] These college degree attainment effects are sizable effects roughly equivalent (in magnitude) to 25 percent of the college degree attainment gap between subsidized meal eligible and ineligible students and 30 percent of this gap between White and Black students in LUSD. I then examine three channels through which the effects of remedial courses might operate.

First, the results indicate that taking a remedial course significantly improves educational resources available to students in the remediation subject such as instruction time, teacher quality, and class size. In particular, I find that taking a remedial ELA course increases instruction time in ELA by roughly an hour each day, increases the leave-out-year value-added scores of teachers in ELA courses by one-third of a standard deviation in teacher value-added scores, and reduces class size in ELA by nearly 3 students. These improved resources translate

[6] http://www.orlandosentinel.com/features/education/school-zone/os-remedial-classes-florida-schools-test-scores-post.html, accessed 12/24/24.

[7] Of these estimates, the estimated effects on the likelihood of enrolling in a highly competitive college, likelihood of persisting beyond the second year, and the likelihood of college degree attainment are statistically different than zero at conventional levels.

into higher test scores in the remediation subject in high school: Taking a remedial ELA course increases 10th grade reading scores by 6.5 percent of a standard deviation (0.065σ), and increases the likelihood of scoring above the proficient level (a requirement for receiving a standard high school diploma in Florida) in the first try by 3.7 percentage points (or by 30 percent of the comparison group mean at the remediation cutoff).

Second, I find that the increased instruction time in the remediation subject significantly reduces time spent in electives that may be beneficial for students (by improving their career readiness or helping then pursue alternative career pathways). For example, taking a remedial course reduces the likelihood that the student takes a CTE course in the year of remediation by 20 percentage points (nearly 60 percent of the comparison group mean at the cutoff), a World language course by 18 percentage points (33 percent), an Arts course by 11 percentage points (50 percent), or a Drama course by 6.1 percentage points (65 percent). This crowding out has effects beyond the remediation year for CTE: taking a high school remedial course reduces the likelihood of ever taking a CTE course in high school by 8 percentage points (roughly 10 percent of the comparison group mean at the cutoff), reduces credits earned in CTE courses in high school by 0.3 credits (20 percent), and reduces the likelihood of being a CTE participant (i.e., earning at least one credit in CTE courses in high school) by 8 percentage points (13 percent).

Third, the findings indicate that remedial courses significantly reduce the likelihood of taking advanced courses in high school. In particular, taking a remedial ELA course reduces the likelihood of taking an advanced ELA course by 16 percentage points (30 percent of comparison group mean at the cutoff), an advanced science course by 8 percentage points (20 percent), and an advanced social studies course by 15 percentage points (40 percent) in the remediation year. [8]

[8] In Florida, high school courses are categorized into three levels based on difficulty: remedial (or intensive), regular, and advanced courses. For example, advanced courses in math include college credit-bearing courses (e.g.,

These tracking effects were also observed in the context of middle school remediation (Özek, 2021; Figlio and Özek, 2024), but unlike remedial courses in middle school that improve advanced course-taking in high school in certain settings, high school remediation has a significant negative effect. For example, taking a remedial course in high school reduces credits earned in advanced high school courses by 0.9 credits (nearly 20 percent of the comparison group mean at the cutoff) and the likelihood of taking a college credit-bearing course in high school by 6 percentage points (15 percent). Mediation analysis suggest that these tracking effects explain nearly half of the adverse effects of high school remediation on postsecondary enrollment in highly competitive institutions and degree attainment.

There is extensive literature examining the causal effects of middle and high school remediation programs in the short term, yet relatively little is known about their effects on postsecondary outcomes and the moderators behind these effects.[9] This study complements several recent studies that investigate the effectiveness of "double dose" of instruction policies in middle and high school. For example, Özek (2021) examines the effects of a similar Florida policy in middle school and finds that middle school remediation improves advanced course-taking in high school and postsecondary outcomes (enrollment, persistence, and degree attainment). More relevant to the purposes of this study, Cortes, Goodman, and Nomi (2015) examine the effects of a double dose of instruction policy in Chicago, which required lower-performing students to enroll in an algebra support course along with the regular algebra course

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AP, IB, AICE courses) and others such as honors courses (e.g., algebra 1 honors, algebra 2 honors, geometry honors), calculus, differential equations, and math for college success. Of the students in the cohorts that I examine in this study, 39 percent took at least one advanced math course, 46 percent took an advanced course in science, and 41 percent took an advanced course in social studies.

[9] For example, several studies provide reviews of the experimental and quasi-experimental literature looking at the efficacy of reading interventions in middle and high school (Baye et al., 2019; Edmonds et al., 2009; Herrera, Truckenmiller, & Foorman, 2016; Scammacca et al., 2007; Wanzek et al., 2013). 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.

in 9th grade, and find that taking the support course increases the likelihood of graduating from high school in four years and postsecondary enrollment.[10]

In contrast, the findings presented in this study reveal that remediation in high school could hurt students' postsecondary success when it hinders student access to advanced courses and crowds out electives that may improve students' college readiness. Further, these postsecondary effects may not fully capture the extent of the detrimental effects of these programs if these electives improve the career readiness of students or help them pursue alternative career paths outside of college, which could improve their labor market outcomes. Overall, this study has two important policy implications.

First, the findings suggest that the tracking effect of high school remediation explains nearly half of its adverse effects on college degree attainment. As such, providing access to more advanced courses (especially in non-remediation subjects) during the year of remediation (similar to the corequisite remediation approach in college) and/or providing remedial courses without crowding out electives (e.g., by extending the school day) may alleviate some of the unintended consequences of these programs. Second, the exploratory analysis also provide evidence suggesting that remedial courses in high school have more adverse effects for students with higher baseline achievement. This is consistent with findings presented in Cortes, Goodman, and Nomi (2015), who find positive effects of double-dose of instruction in a high school setting that targeted more disadvantaged and lower-performing students. As such, a key challenge for policymakers in this context is to set the remediation threshold at a point that maximizes the value of the remedial course and minimizes its "opportunity cost".

[10] Several recent studies have also examined the effects of high school transition interventions that target 11th and 12th graders to improve college readiness (e.g., Pheatt et al., 2016, Mokher et al., 2018, Kane et al., 2019; and Xu et al., 2022). The overarching conclusion of these studies is that these interventions may reduce college remediation placement, yet they have no significant effect on college persistent and degree attainment.

2. Florida's High School Remediation Policy

As part of a broader push towards educational accountability in Florida where standardized test scores carried important ramifications for students, Florida enacted remediation requirements for low-performing students in middle school (s.1003.415 in 2004 and s.1003.4156 in 2006) and in high school (s.1004.428 in 2006). In particular, Florida's middle and high school remediation policies required students who scored in the lowest two achievement levels (out of five) on the standardized, statewide reading and mathematics assessments to receive remediation in that subject in the following year.

The type of remediation that students receive (an additional remedial course or remediation in a regular content area course) varies based on subject, the achievement level of students, and their individual education needs. For example, the policy stated that "For each year in which a student scores at Level l on FCAT Reading, the student must be enrolled in and complete an intensive reading course the following year. Placement of Level 2 readers in either an intensive reading course or a content area course in which reading strategies are delivered shall be determined by diagnosis of reading needs." In math, the policy requires students in the lowest two achievement levels to receive remediation but leaves the decision to place students in additional remedial courses or provide remediation in regular math courses to the school districts and schools.[11]

There are exemptions to this requirement: For example, students may be exempt from taking an additional remedial course in ELA if they have higher remediation needs in math. That said, the policy significantly increased remedial course-taking in middle and high school in the

[11] This requirement was eliminated in 2015 (HB 7069) and the state left the remediation decision to the individual school districts, yet many school districts in Florida still require low-performing students in middle and high school to take these courses. For example, nearly a quarter of all high school students in Florida took a remedial ELA course in 2022-23 school year.

state (e.g., Figlio and Ozek, 2024).[12] For example, in the large, urban school district (LUSD) in Florida during the time frame that I examine in this study, 24 percent of all high school students took a remedial ELA course.[13] While I am unable to identify students who received ELA remediation in content area courses, the findings presented below suggest that students whose prior year test scores fell right below the ELA remediation cutoff in LUSD were significantly more likely to take an additional remedial course in ELA. In contrast, remedial course-taking in math was much less common in the LUSD during this time frame: Only 5 percent of all high school students took a remedial math course. As such, I focus on the effects of remedial ELA courses in this study.

The legislation aimed to improve student achievement by providing additional instructional resources to students in the remedial schedule. The first channel in this context is additional instruction time in the remediation subject, which has been shown to be an effective policy lever in other contexts (e.g., Figlio, Holden, & Özek 2018; Taylor 2014; and Nomi and Allensworth 2009). The second channel is the delivery of personalized course content by effective teachers in smaller classroom settings.[14] In particular, Florida's policy required districts

[12] 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 or may be placed in content area course in which reading strategies were delivered.

[13] These rates were even higher among students in early high school grades with nearly 30 percent of all 9th and 10th graders taking a remedial ELA course. In contrast, only 10 percent of 12th graders took a remedial ELA course in the LUSD during this time frame.

[14] There is extensive literature illustrating the importance of effective teachers for 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. Along similar lines, 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 a standard deviation in test scores based on research by Krueger (1999). As such, Florida's policy could improve reading achievement by requiring effective teachers to be assigned to remedial reading courses in smaller classroom settings.

to (1) provide differentiated support based on the academic needs of students in the remedial schedule[15]; (2) staff remedial ELA courses with teachers who have the Reading Endorsement or Certification in Reading and evidence of success (as determined by the district); and (3) provide remedial courses in classrooms with adequate infrastructure (class size, materials). Recent studies provide evidence about fidelity of implementation of the policy in middle school and show that students placed in the remedial schedule indeed received additional resources in the year of remediation (Figlio and Özek, 2024; Özek, 2021).

On the other hand, being placed in the remedial schedule in middle school under Florida's policy has also been shown to prevent students from taking advanced courses (in both remediation and non-remediation subjects) and crowd out electives since the remediation was provided during regular school hours (Figlio and Özek, 2024; Özek, 2021).[16] While these tracking and crowding out effects in middle school do not lead to adverse effects on high school and postsecondary outcomes (Özek, 2021), they may be more consequential in a high school setting. For example, tracking in high school could prevent students from taking college credit-bearing courses (or other advanced high school courses that are prerequisites for college credit-bearing courses)[17], which have been shown to improve postsecondary outcomes (Smith, Hurwitz, and Avery, 2017). Similarly, tracking could change the classroom-peer composition of students in the remedial schedule, which may be consequential given the importance of high school peers on postsecondary outcomes (e.g., Bifulco et al., 2014), or lead to student disengagement from

[15] For example, the remedial ELA course could 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.
[16] This was also shown to be an important concern in high school transition courses in 11th and 12th grades that crowd out advanced high school courses such as per-calculus and trigonometry (Kane et al., 2019; Mokher et al., 2018).
[17] In contrast, middle school students placed in the remedial track may have more time to catch up and take the courses necessary for college credit-bearing courses in high school.

schools due to the stigma associated with being labeled as low-performing, which, in the high school setting, may cause higher dropout rates. Finally, the crowding out effect could be more severe in high school if it hinders students' ability to pursue alternative career pathways.

3. Data

In this study, I make use of detailed longitudinal, student-level school records from a LUSD in Florida that cover all students enrolled in grades 6–12 between 2005–06 and 2018–19 school years and include reading and mathematics scores of all tested students.[18] 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 include 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 2019 which allow me to observe postsecondary enrollment, college selectivity and completion for students.

In the main analysis, I focus on 4 cohorts of 9th graders between 2008-09 and 2011-12 school years and 3 cohorts of 10th graders between 2009-10 and 2011-12 in LUSD. These are the high school students who were old enough to attain a 4-year college degree by the end of the time frame included in the NSC records. I exclude 11th graders from the analysis since the

[18] 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.

remediation cutoff on the 10th grade ELA test (i.e., achievement level 2/3 threshold) was also used as a criterion for high school graduation in Florida (hence violating the exclusion restriction in the fuzzy RD analysis); and 12th graders because remedial courses were not as common for high school seniors.

Table 1 compares the baseline characteristics/outcomes of students in the sample by their remediation status. In particular, the first two columns of Table 1 compare the baseline attributes/outcomes of students in the entire sample based on remediation status; the third and fourth columns examine these differences in the RD sample (students within 20 points around the ELA remediation cutoff); and the last two columns examine these differences for students within 20 points below the cutoff to present differences between compliers and non-compliers below the cutoff in the RD sample.

The first two columns of Table 1 suggests that students placed in the remedial schedule had significantly lower ELA and math scores (by design), were significantly more likely to be involved in disciplinary incidents, had more absences, and were more (less) likely to have taken a remedial (advanced) course in the prior year, were more likely to be eligible for subsidized meals in school, and were more likely to be Black. These differences decline considerably, yet still exist, when I restrict the sample to those around the cutoff in the third and fourth columns and imply that a naïve comparison between the postsecondary outcomes of students taking remedial high school courses and others will likely yield biased estimates of the causal effects of these courses.

4. Empirical Framework

To deal with this selection issue, I rely on an RD design leveraging the non-linearity in treatment likelihood at the student-level treatment cutoff based on the prior year reading scores of students. Panel (A) in Appendix Figure 1 illustrates this non-linearity and shows that high school students whose prior year reading scores fell right below the remediation cutoff (the threshold between achievement level 2 and 3) were roughly 45 percentage points more likely to take a remedial ELA course compared to students right above this threshold. The last two columns of Table 1 indicate that students below the remediation cutoff who were placed in the remedial schedule were comparable to non-compliers with slightly lower prior test scores and higher likelihood of having taken a remedial ELA course in the previous year, yet had comparable prior disciplinary incidents and absences, demographics, and other baseline characteristics.

Using this discontinuity in remediation likelihood, I estimate the causal effect of being placed in the remedial schedule in ELA (and thus taking an additional remedial ELA course) in high school 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 grade-by-year fixed-effects. I estimate this model using the linear polynomial specification and a bandwidth of 20 points 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 2. I present Eicker-Huber-White heteroskedasticity-robust standard errors as recently suggested by Kolesár and Rothe (2018), and present standard errors clustered at the running variable level (as suggested by Lee and Card, 2009) in Appendix Figure 2.

Table 2 compares the outcomes of interest for all students in the cohorts used in the analysis (first two columns), students in the RD sample (third and fourth columns), and for students in the RD sample who scored below the remediation cutoff (last two columns) by their remediation status. Consistent with the findings presented in Table 1, I find that students who were placed in the remedial schedule had worse educational outcomes compared to other students: This is true overall and for students in the RD sample. Compliers and non-compliers below the cutoff have comparable future outcomes, with nearly half of them enrolling in a 4-year college, 20 percent enrolling in a highly competitive college, and 25 percent obtaining a 2- or 4-year college degree.

The parameter of interest, β, is an unbiased estimate of the causal effect of being placed in the remedial schedule in high school under three assumptions: (1) all baseline student attributes (other than the treatment status) are smooth through the cutoff; (2) there is no manipulation of the running variable around the cutoff (McCrary 2008; Lee and Lemieux 2010); (3) scoring below the remediation cutoff only affects student outcomes through its effect on the likelihood of taking a remedial course (i.e., exclusion restriction). To check for (1), the first column in Table 3 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 20 points and the linear polynomial specification in (1), and the estimated coefficient indicates the size of the discontinuity (the numbers in brackets represent the comparison group mean at the cutoff). Out of the 14 estimates, only 1 of them is statistically distinguishable from zero at conventional levels, and none of the estimates imply a discontinuity larger than 10 percent of the dependent variable mean at the cutoff.[19]

To check for the validity of the second assumption, panel (B) in Appendix Figure 1 presents the distribution of the running variable around the remediation cutoff. It is important to note that running variable manipulation is unlikely in this context since scores are assessed without any teacher, student, or principal involvement. The figure reveals no unusual discontinuity at the cutoff and I reject the hypothesis on discontinuity in the density of the distribution at the cutoff, with a p-value of 0.124 (Frandsen, 2017). I discuss the third assumption in detail in Section 5.5.

Student attrition is another important concern in this context. While attrition can be regarded as a dependent variable to the extent that it reflects student dropout, being placed in the remedial schedule may also lead certain students to leave LUSD to pursue their schooling elsewhere (e.g., move to another district, a private school), graduate from high school, and attain a college degree – outcomes that are not observed in LUSD data for these students. Roughly 12 percent of the students in the sample left LUSD and move to another district or private school (i.e., district/sector switchers) in high school. Appendix Table 1 compares the baseline characteristics of these students with stayers (those who never left LUSD or left schooling altogether), and shows that district/sector switchers had significantly lower prior year test scores,

[19] 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 also check the robustness of the main findings to the inclusion of school fixed effects (results are available upon request) and show that the main conclusions remain unchanged.

were more disadvantaged economically, and were significantly more likely to be involved in a disciplinary incident in the prior year.

In the high school and postsecondary outcome analysis, I present two sets of results: (1) analysis that include these switchers and assume that all district/sector switchers had the "negative" outcome (e.g., did not receive a high school diploma or enrolled in college), which is likely given their baseline characteristics; and (2) analysis that drop these students. 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. I check the effect of being placed in the remedial schedule on the likelihood of leaving LUSD in high school (using the fuzzy RD framework described in equations (1) and (2)) and find a β of -0.016 (p-value: 0.368), which correspond to less than 10 percent of the comparison group mean at the cutoff. Further, to examine the extent of differential attrition, I repeat the falsification exercise presented in Table 3 excluding the district/sector switchers (results provided in the second column of Table 3), and find strong evidence that differential attrition is not a major concern in the analysis. I also present the results of additional robustness checks in Section 5.5 to ensure that the main results are not driven by differential attrition from the sample.

Finally, an important concern in estimating the long-term effects of the remediation policy in Florida is the dynamic treatment assignment issue discussed in Taylor (2014) and Özek (2021). 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. To check the extent of this issue, I estimate the effect of being placed in the remedial track on the likelihood of taking a remedial ELA course in the following two years and find a β of 0.024 (p-value: 0.363) in the first year and -0.007 (p-value: 0.764) in the second year, both of which correspond to effect sizes less than 10 percent of the comparison group mean at the cutoff. These findings provide evidence that dynamic treatment assignment is not a major issue in this analysis.

5. Results

5.1. Effects on Educational Resources in the Year of Remediation

Does being placed in the remedial schedule increase educational resources for students in the remediation subject as the legislation intended? The first four rows of the first column in Table 4 examines the effect of taking a remedial ELA course on educational inputs such as instruction time in ELA, average class size, average teacher experience, and teacher leave-out-year value-added scores of teachers in ELA courses using cohorts before 2012-13 school year for whom the data are available (Figure 1 presents a graphical depiction for some of these outcomes).[20] All regressions control for the student baseline characteristics listed in Table 3 to improve the precision of the estimates (note that the point estimates remain virtually unchanged without these covariates as one would expect based on the baseline equivalence results presented in Table 3).

[20] I calculate average class size, teacher experience, and teacher value-added using the time spent in each classroom (minutes per week) as weights across all ELA courses the student takes in a given school year. I calculate leave-out-year value-added scores in reading similar to Chetty et al. (2014) using the STATA command *vam* and the reading scores of students linked to their teachers in high school ELA courses (grades 9 and 10) 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 et al. (2014).

The findings reveal significant positive effects of being placed in the remedial schedule on educational resources in ELA courses in high school. In particular, taking an additional remedial ELA course increases instruction time in ELA by 300 minutes per week (60 minutes per day), roughly doubling the instruction time in this subject for comparison students at the cutoff. Similarly, being placed in the remedial schedule increases the average teacher value-added in ELA courses by one third of a standard deviation in teacher value-added scores, and reduces average class size by nearly 3 students.

How about resources in other courses? The second and third columns of Table 4 examine the same educational inputs in other core subjects (math, science, and social studies) and elective courses respectively. The findings suggest that the additional instructional time for the remedial ELA course comes entirely out of time spent in electives: Being placed in the remedial schedule reduces time spent in electives by 253 minutes per week (50 minutes per day). The findings also suggest that being placed in the remedial schedule in ELA reduces the average teacher experience in other core courses by a year, and increases the likelihood of being assigned to a novice teacher (with less than 3 years of experience) by 4 percentage points (about 30 percent of the comparison group mean at the cutoff). I find no significant effects on class size in other core courses or electives.

5.2. Effects on Course-Taking in the Year of Remediation

How does being placed in the remedial track in ELA affect student course-taking in the remediation year? Two recent studies show that being placed in the remedial schedule in middle school significantly affect student course-taking (Özek, 2021; Figlio and Özek, 2024). Table 5 examines this question in a high school context and presents the estimated effects on the likelihood of taking different electives and advanced courses in core subjects (Figure 2 presents a graphical depiction for some of these outcomes).

The findings indicate that taking an additional remedial course significantly reduces the likelihood that the student takes a CTE course in the year of remediation. In particular, being placed in the remedial track reduces the likelihood of taking a CTE course by 19 percentage points, which is roughly equivalent to 55 percent of the comparison group mean at the cutoff. I also find sizable effects for World languages (18 percentage points or 30 percent of the comparison group mean), Drama (6 percentage points or 60 percent), and Arts (13 percentage points or 50 percent).

The results also suggest that being placed in the remedial schedule significantly reduces the likelihood that the student takes advanced courses in both the remediation subject and other core subjects. In particular, the estimates presented in the bottom panel of Table 5 suggest that taking an additional remedial course in ELA reduces the likelihood of taking an advanced ELA course by 15 percentage points (30 percent), an advanced science course by 7 percentage points (16 percent), and advanced social studies course by 15.7 percentage points (38 percent). Overall, being placed in the remedial schedule in ELA reduces the likelihood of taking an advanced course in other core courses by 9.6 percentage points (15 percent).

The tracking effect of high school remediation significantly reduces classroom-peer prior achievement, which could be consequential given the evidence on the importance of high school peers on postsecondary outcomes (e.g., Bifulco et al., 2014). The last row of Table 4 examines the effect of being placed in the remedial schedule in ELA on the average classroom-peer prior year test scores in ELA, other core subjects, and electives. The results indicate that being placed in the remedial schedule in ELA reduces classroom-peer prior achievement by 0.524σ in ELA, 0.150σ in other core subjects, and 0.066σ in electives. The average 9th grader in LUSD gained about 0.25σ in reading scores between 8th and 9th grade in LUSD during the time frame I examine, which implies that the effect of remediation on classroom-peer prior achievement in ELA (other core courses) is equivalent to placing students in classrooms where the average peer is roughly 2 (0.6) years behind. This tracking effect in non-remedial subjects could also explain the effect on teacher experience in those courses presented in Table 4: in LUSD, teachers assigned to advanced high school courses were less likely to be novice (0-2 years of experience) compared regular high school courses.[21]

5.3. Effects on High School Outcomes

Table 4 and Table 5 reveal competing channels through which high school remediation could influence postsecondary outcomes. On the one hand, there is the improved educational resources in the remediation subject; on the other hand, there are the tracking and crowding out effects of remediation. How do these effects in the remediation year influence high school outcomes beyond the year of remediation? Table 6 examines this question and examines the effects of being placed in the remedial schedule on 10th grade test scores, high school course-taking, disciplinary incidents, absences, and high school graduation (Figure 3 presents a graphical depiction for some of these outcomes).

The results paint a mixed picture. On the one hand, the improved educational resources in ELA seem to have increased student reading scores in 10th grade, which is important in Florida because the state requires high school students to score above the proficient level on the 10th grade reading test to obtain a high school diploma. In particular, taking a remedial ELA course in

[21] For example, 18 percent of teachers assigned to regular math and science courses in high school had fewer than 3 years of experience in LUSD compared to 13 percent among teachers assigned to advanced courses in those subjects.

9th or 10th grade increases 10th grade reading scores by 0.06σ to 0.065σ and increases the likelihood that the student passes the 10th grade reading test on the first try by 3.4 to 3.7 percentage points (roughly 25 percent of the comparison group mean at the cutoff).[22]

On the other hand, tracking and crowding out in the remediation year significantly affect student course-taking throughout high school. For example, being placed in the remedial schedule reduces the likelihood that the student ever takes a CTE course in high school by 6.9 percentage points (10 percent), CTE credits earned in high school by 0.25 credits (16 percent), and the likelihood of being a *CTE participant* (taking at least one credit of CTE courses in high school) by 6.5 to 6.8 percentage points (11 percent).

Similar findings emerge for advanced course-taking in high school: Being placed in the remedial schedule in 9th or 10th grades reduces credits earned in advanced courses in high school by 0.85 to 0.9 credits (13 percent) and the likelihood of taking a college credit-bearing course (AP/IB) by 7.1 to 7.6 percentage points (18 percent). And these tracking effects are not confined to the remediation subject: high school remediation reduces the credits earned in advanced courses in other subjects by 0.54 to 0.57 credits (12 percent) and the likelihood of taking a college credit-bearing course in other subjects by 6.2 to 6.9 percentage points (17 percent). I find no significant effect on disciplinary incidents and absences in high school, but the results suggest negative and significant effect on the likelihood of graduating from high school when the switchers are excluded. In particular, using this sample, I find a negative effect of 4.9 percentage points (6 percent) for high school graduation.

[22] The positive effects on short-term test scores might seem contradictory to the earlier finding that current remediation does not lead to significant changes in the likelihood of future remediation. There are several possibilities. For example, it is important to note that the positive effect on 10th grade test scores is rather small (0.06σ), which may not be sufficient to move these students above the proficiency threshold (at least to the extent that would meaningfully reduce future remediation). Second, as mentioned earlier, there is some teacher/principal discretion about what happens when students score above/below the cutoff. As such, students may (or may not) be placed in remediation in the following year if they score above (or below) the remediation cutoff.

5.4. Effects on Postsecondary Outcomes

Finally, Table 7 presents the estimated effects of being placed in the remedial ELA schedule in high school on postsecondary enrollment, college selectivity, persistence, and degree attainment (Figure 4 presents a graphical depiction of these findings), with the first and second columns showing the results with and without the switchers respectively. The findings reveal significant adverse effects of high school remediation on postsecondary outcomes, especially for college persistence and degree attainment. Being placed in the remedial schedule reduces the likelihood of enrolling in a 4-year college by 4.2 to 5.3 percentage points (roughly 7 percent of the comparison group mean at the cutoff) although the estimated effect is different from zero at 10 percent level or higher only in the case when the switchers are excluded (p-value of 0.125 in the first column versus 0.06 in the second). Remediation also reduces the likelihood of enrolling in a "very competitive" college (based on NCES-Barron's Admissions Competitive Index) by 4.4 to 5.3 percentage points (or by 17 percent), persistence beyond the second year by 5.6 to 7 percentage points (or by 12 percent), obtaining a 2-year college degree by 4.9 to 5.9 percentage points (by 22 percent), a 4-year degree by 5.2 to 6.3 percentage points (17 percent), and any college degree by 5.1 to 6.2 percentage points (17 percent).

To better understand the magnitude of these effects, it is helpful to compare them to racial/ethnic and socioeconomic gaps in postsecondary outcomes in LUSD. For example, a 6-percentage point effect on college degree attainment corresponds roughly to 25 percent of the college degree attainment gap between students eligible for subsidized meals and others, and 30 percent of this gap between White and Black students in LUSD. As such, the adverse effects of high school remediation on postsecondary outcomes represent sizable effects.

5.5. Robustness Checks

Appendix Figure 2 checks the sensitivity of the main findings presented in Table 6 and Table 7 to bandwidth selection and standard error clustering. In particular, each spike presents the β coefficient estimated using linear $k(S)$ for bandwidths between 16 and 30 with solid spikes presenting 95% confidence intervals obtained using Eicker-Huber-White heteroskedasticity-robust standard errors and dashed spikes presenting confidence intervals obtained using standard errors clustered at the running variable level. The estimated discontinuities at the cutoff are very robust to bandwidth selection, especially for high school outcomes. For postsecondary outcomes, 95% confidence intervals occasionally include zero, but even so, the estimated coefficients are statistically different than zero at the 10 percent level or higher in 8 cases (out of 16) for "very competitive" college enrollment, 14 cases for persistence beyond second year, and 14 cases for college degree attainment. Along similar lines, Appendix Table 2 presents the effects of taking a remedial ELA course estimated nonparametrically using optimal bandwidths with and without the school/sector switchers (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.

Another potential issue in the fuzzy RD design used in this study is violation of the exclusion restriction (i.e., the possibility that "non-compliers" below the cutoff were also treated). In other words, some students who were flagged for remediation (by scoring below the cutoff) may have received instructional support in content area courses even though they were not required to take an additional remedial ELA course. I check this possibility by comparing the educational resources available to low-performers in ELA based on whether they were placed in remedial schedule, holding other student attributes listed in Table 3 constant. The findings suggest that low-performing compliers received significantly more educational resources in the remediation subject compared to non-compliers. Low-performing students who take remedial ELA courses spend 194 minutes more per week in ELA courses, are assigned to classrooms with 2.5 fewer students, more experienced teachers (1.64 more years of experience) with higher value-added scores in reading. These findings provide suggestive evidence that (a) non-compliers 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.

With these findings in mind, Appendix Table 3 presents the estimated effects of scoring below the remediation cutoff and still reveals sizable effects. Scoring below the remediation cutoff increases 10^{th} grade reading scores by 0.03σ, reduces credits earned in CTE courses by 8 percent of the comparison group mean at the cutoff, reduces credits earned in advanced courses by 5 percent, enrolling in a highly selective college by 10 percent, and attaining a college degree by 7 percent.

Appendix Table 4 further checks the robustness of the postsecondary results reported in Table 7 to different assumptions about the students who left the sample before graduating from high school (Table 7 presents results from analysis assuming the worse outcome for these students in the first column and dropping them altogether from the analysis in the second column). In particular, the first column of Appendix Table 4 imputes the worse outcome for these students (similar to the first column of Table 7), the second column imputes the predicted outcome for these students using their baseline characteristics listed in Table 3, and the last column imputes the better outcome for these students.[23] The results of this exercise provide strong evidence that the results in Table 6 are not driven by differential attrition: the main conclusions remain virtually unchanged under different assumptions about the switchers.

[23] To obtain the predicted outcomes, I regress the outcomes of interest excluding the district/sector switchers on the baseline characteristics/outcomes listed in Table 3 and impute the predicted values to the switchers.

5.6. Mediation Analysis

To what extent do the effects of remedial courses on high school outcomes explain their adverse effects on postsecondary outcomes? In Table 8, I present the results of an exploratory analysis to address this question. In particular, in column (I) of the top panel, I present the estimated effects on postsecondary outcomes reported in the first column of Table 7. In column (II), I repeat the same analysis controlling for high school outcomes used in Table 6. The bottom panel presents the results excluding district/sector switchers in the sample.

The results suggest that the effects of remedial courses on high school outcomes explain a sizable portion of their effects on postsecondary outcomes. For example, looking at the top panel, the high school outcome effects explain roughly 60 percent of the high school remediation effects on the likelihood of enrolling in a highly competitive college, 75 percent of the effect on persistence in college beyond second year, and roughly 60 percent of the effect on college degree attainment. Similar results emerge when I exclude district/sector switchers from the sample.

Appendix Table 5 takes a closer look at this question and examines whether certain high school outcomes serve as stronger mediators behind the observed effects on postsecondary outcomes. Similar to Table 8, column (I) of this table presents the estimated effects on the corresponding outcome of interest (likelihood of enrolling in a highly selective college in the top panel, persisting beyond second year in college in the middle column, and 2- or 4-year college degree attainment in the bottom panel) reported in Table 7 whereas column (II) adds the high school outcome listed in the first column as a covariate.

The findings suggest that the tracking effect explains a considerable portion of the total effect of remediation on postsecondary outcomes. For example, the negative effect of being placed in the remedial schedule on the number of credits earned in advanced high school courses explains roughly 70 percent of its effect on the likelihood of being enrolled in a highly competitive college, 65 percent of its effect on the likelihood of persisting beyond second year in college, and 60 percent of its effect on 2- or 4-year degree attainment. In contrast, the negative effects of remedial courses on high school graduation explains 21 percent of its effect on enrolling in a highly competitive college, 31 percent of its effect on persisting beyond second year, and 22 percent of its effect on degree attainment. The crowding out effect of high school remediation on CTE courses also fail to explain much of its effects on postsecondary enrollment and graduation.

5.5. Differential Effects of Remediation by Baseline Achievement

An important limitation of the fuzzy RD approach used in this study is that the estimated effects only apply to students right around the remediation cutoff. Yet, understanding the differential effects of these courses on students based on their baseline achievement is important as the benefits may be larger for students with higher educational needs. To examine this question, I follow two approaches.[24]

First, in Table 9, I present the estimated effects on high school and postsecondary outcomes broken down by whether the student was proficient in ELA two years prior. The results indicate that the adverse effects of the remedial course are much more pronounced for students who were higher performing in ELA two years earlier (although the estimated effects for the two groups are not statistically distinguishable at conventional levels). For example, the negative effects on CTE course-taking in high school, advanced course-taking in high school in non-remediation subjects, likelihood of taking a college credit-bearing course in high school,

[24] I did not find any meaningful (economically and/or statistically) differences in the effects of being placed in the remedial schedule on high school and postsecondary outcomes by race/ethnicity, subsidized meal eligibility, grade, or gender.

college persistence, and college degree attainment are only statistically different than zero at conventional levels for higher-performing students.

The differences in effect sizes are also meaningful: For example, being placed in the remedial schedule reduces the likelihood of taking a college-credit bearing course in high school by 1.8 percentage points (p-value: 0.664) for lower-performing students (corresponding to roughly 5 percent of the comparison group mean at the cutoff) versus a reduction of 9.4 percentage points (p-value: 0.004) for higher-performing students (roughly 20 percent of the comparison group mean). Similar findings emerge for college degree attainment: I find a positive effect of 0.16 percentage points (p-value: 0.968) of remedial courses on 2- or 4-year degree attainment (0.6 percent of the comparison group mean at the cutoff) for lower-performing students versus a negative effect of 6.3 percentage points (p-value: 0.048) for higher-performing students (18 percent of the comparison group mean at the cutoff).

Second, I examine the estimated effects of taking a remedial ELA course away from the cutoff using the global RD approach developed by Opper and Özek (2023). While the technical aspects and formal motivation of that estimator is beyond the scope of this study, the intuition is as follows. To obtain the treatment effects away from the cutoff in a fuzzy RD design, global RD design is equivalent to first estimating the local average treatment effect (LATE) in equation (2) using a traditional fuzzy RD approach. Using the observed conditional moments at the discontinuity, it then extrapolates the LATE estimate to an estimate of conditional average treatment effect (CATE) at the cutoff using the linear approach in Brinch et al. (2017) and Kowalski (2023). Finally, the global RD design generates the estimated treatment effects away from the discontinuity by adjusting the observed differences between the treatment and control means under the assumption that selection to treatment stays constant (i.e., observed and unobserved factors that contribute to treatment do not meaningfully change as one moves away from the cutoff).

Figures 5 and 6 present the estimated CATE of being placed in the remedial schedule along with the 95 percent confidence intervals at the cutoff and at points away from the cutoff for postsecondary and high school outcomes respectively. Consistent with findings presented in Table 9, this exercise reveals that that remedial ELA courses could be more beneficial for students with lower baseline achievement. For example, suppose the state and districts moved the remediation cutoff from the 2/3 threshold (based on prior year achievement level in reading) to the 1/2 threshold, which roughly corresponds to the running variable value of -45 on the x-axis. The findings suggest that being placed in the remedial schedule would improve student 10th grade scores by 0.15σ for the students at this new cutoff and lead to a positive and significant effect on high school graduation rates. In contrast, high school remediation at this new cutoff would not have an adverse effect on credits earned in advanced high school courses or CTE courses, and have zero effect on postsecondary outcomes with the exception of a positive and significant effect on enrollment in highly selective colleges.

The results presented in Table 9 and Figure 6 could also explain the discrepancy between the findings of this study and those presented in Cortes, Goodman, and Nomi (2015), who find significant positive effects of double-dose of algebra instruction in 9th grade on high school graduation and postsecondary enrollment in Chicago. The sample of students used in the RD analysis of this study are significantly less likely to come from economically disadvantaged backgrounds and are higher performing than those used in the RD analysis of Cortes, Goodman, and Nomi (2015).[25] Given the findings in Table 9, Figure 5, and Figure 6 that indicate that

[25] For example, 92 percent of the students in the RD sample of Cortes, Goodman, and Nomi (2015) were eligible for subsidized meals (i.e., eligible for free- or reduced-priced lunch) compared to 58 percent in the RD sample used in

remedial courses are more beneficial for lower-performing students (and may have adverse effects for students with higher baseline achievement), the discrepancy in findings could be driven by the differences in the marginal students targeted by the remediation policies in Chicago Public Schools and LUSD.

6. Concluding Remarks

Do remedial courses in high school improve postsecondary outcomes for students? I address this question using a Florida policy that requires low-performing high schoolers to take an additional remedial course in ELA and a regression discontinuity design. I show that while the policy provided additional educational resources to students in the subject of remediation (and improved reading achievement) as intended, it also led to tracking, which significantly reduced advanced course-taking in high school not only in the remediation subject but also in other core courses, and crowded out electives such as CTE courses, which may be consequential for students in the long-run as they may improve career readiness and allow students pursue alternative career pathways. The findings also suggest that high school remediation may reduce postsecondary enrollment, persistence, and degree attainment.

The study also reveals two findings with important policy implications. First, I find that the tracking effect of high school remediation explains nearly half of its adverse effects on college degree attainment. As such, providing remediation while allowing these students to take advanced courses (especially in non-remediation subjects) and outside of regular school hours (so that these courses do not crowd out important electives) could help alleviate some of these concerns. Second, the results suggest that students with lower baseline reading achievement benefit more from these courses; in fact, remedial courses led to no adverse effects on

this study. Similarly, 30 percent of the students in the RD sample of Cortes, Goodman, and Nomi (2015) enrolled in any college, compared to 58 percent in the RD sample used in this study.

postsecondary outcomes for these students with some positive and significant effects on reading achievement, high school graduation, and selective college enrollment. Therefore, focusing on lower-performing students when identifying students to be placed in the remedial schedule may improve the efficacy of the policy.

How can we reconcile the findings of this study with the findings of the three earlier studies that found positive (or null) effects of the same policy in Florida in middle school (Taylor, 2014; Özek, 2021; Figlio and Özek, 2024)? One possibility is that being held back (in terms of course content) has a more adverse effect in later grades as students have less time to catch up. This has also been observed in grade retention context where early grade retention policies that provide instructional support have been shown to improve student outcomes (Jacob and Lefgren, 2004; Greene and Winters, 2007; Greene and Winters, 2012; Mariano and Martorell, 2013; Schwerdt et al., 2017; Figlio and Ozek, 2020; Hwang and Koedel, 2023; Mumma and Winters, 2023) while retention policies in later grades that provide similar supports yield no benefits and even lead to negative effects (Jacob and Lefgren, 2009; Eren et al. 2017; Mariano et al, 2018; Larsen and Valant 2018; Eren et al. 2022). It is also possible that being labeled as low performing has a more detrimental stigma effect on older students, leading to student disengagement from schooling. While I am unable to directly test for this hypothesis, the finding that being placed in the remedial schedule in high school has no effect on student attendance and disciplinary incidents (two possible consequences of student engagement) and a small negative effect on high school graduation provides suggestive evidence that student disengagement in high school is unlikely to be a major driver of the postsecondary effects. Instead, the larger effects on college persistence and degree attainment (compared to college enrollment and high school graduation) seem to suggest that it is the effect of high school remediation on college readiness (driven by its tracking effect) that is the main channel behind the findings.

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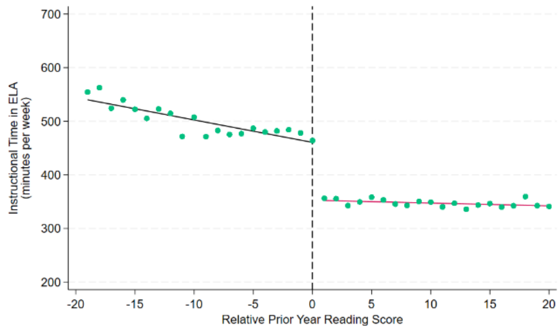
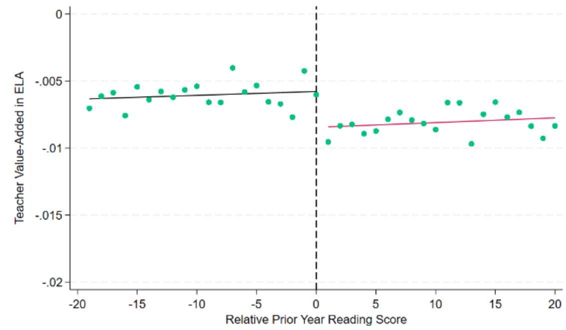
Figure 1. Classroom Inputs in ELA Courses Around the Remediation Cutoff, Remediation Year

(A) Instructional time

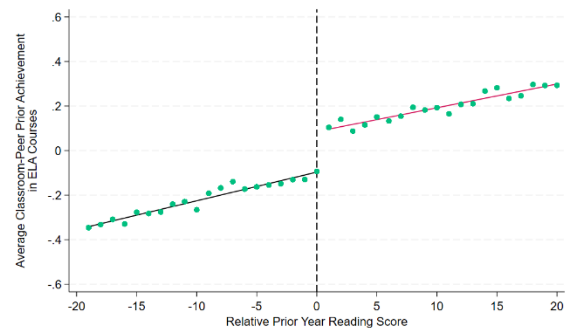


(B) Teacher value-added



(C) Class size

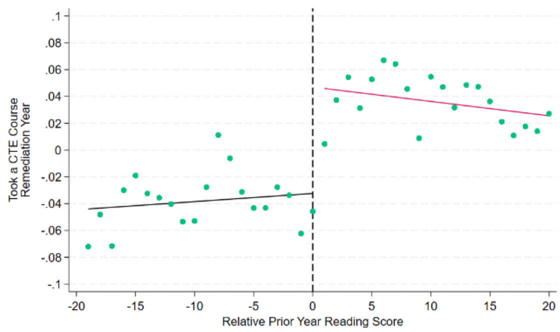
(D) Classroom-peer prior test scores



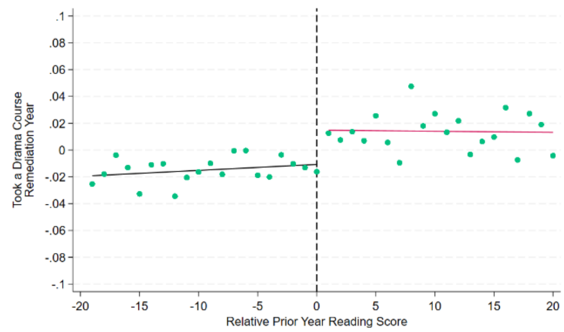
Notes: The figure presents the raw cell means of the averaged classroom inputs for each reading score between 20 points below and 20 points above the remediation cutoff. The solid lines represent the linear fit estimated separately for the left of the cutoff score and the right. All panels exclude district/sector switchers.

Figure 2. Course-Taking in Remediation Year Around the Remediation Cutoff

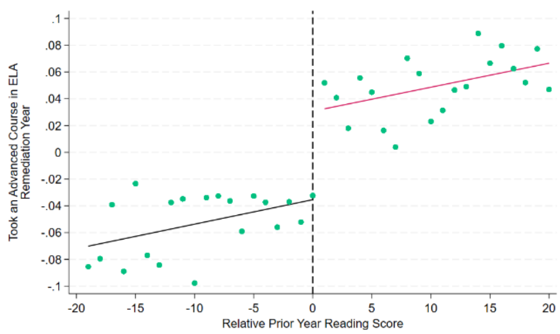
(A) Took a CTE course



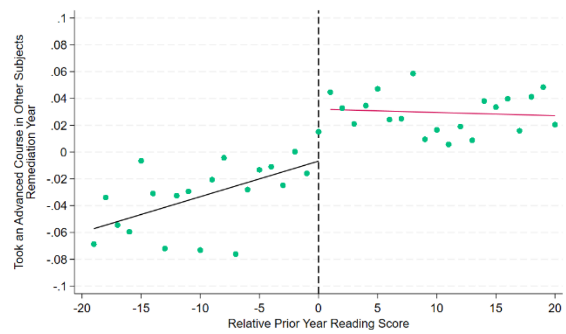
(B) Took a Drama course



(C) Took an advanced course in ELA

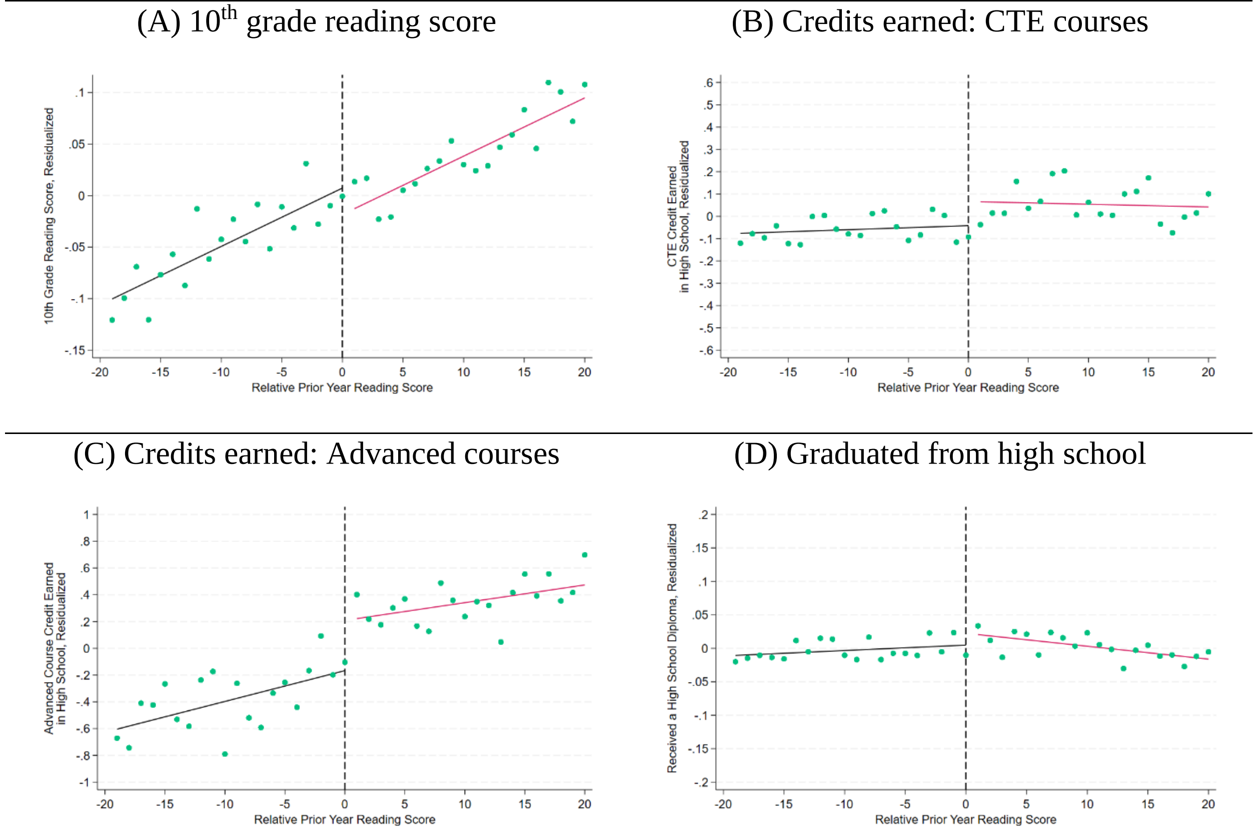


(D) Took an advanced course in other subjects



Notes: The figure presents the raw cell means of the averaged course-taking indicators in the remediation year (residualized using the student characteristics included in Table 3 along with grade-by-year fixed-effects) for each reading score between 20 points below and 20 points above the remediation cutoff. The solid lines represent the linear fit estimated separately for the left of the cutoff score and the right. All panels exclude district/sector switchers.

Figure 3. High School Outcomes Around the Remediation Cutoff

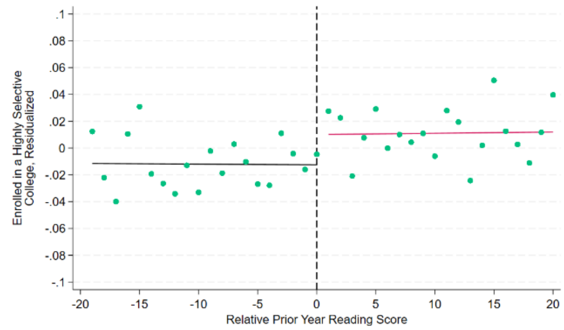


Notes: The figure presents the raw cell means of the averaged high school outcomes (residualized using the student characteristics included in Table 3 along with grade-by-year fixed-effects) for each reading score between 20 points below and 20 points above the remediation cutoff. The solid lines represent the linear fit estimated separately for the left of the cutoff score and the right. All panels exclude district/sector switchers.

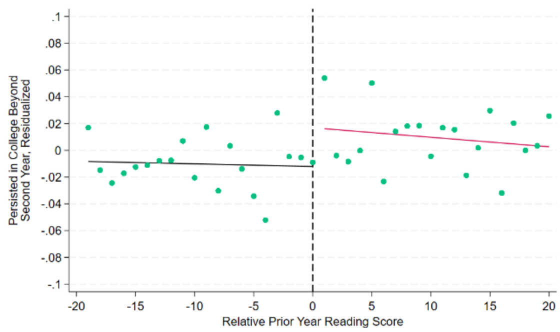
Figure 4. Postsecondary Outcomes Around the Remediation Cutoff

(A) Enrolled in a 4-Year College

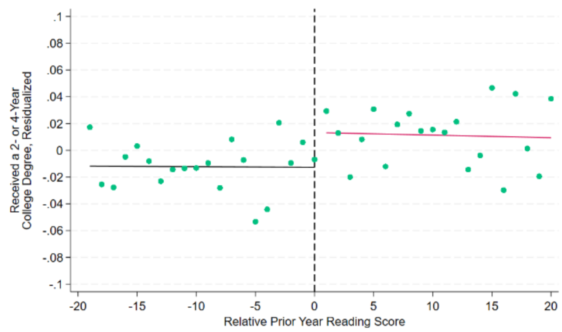
(B) Enrolled in a "Very Competitive" College



(C) Persisted in College Beyond Second Year



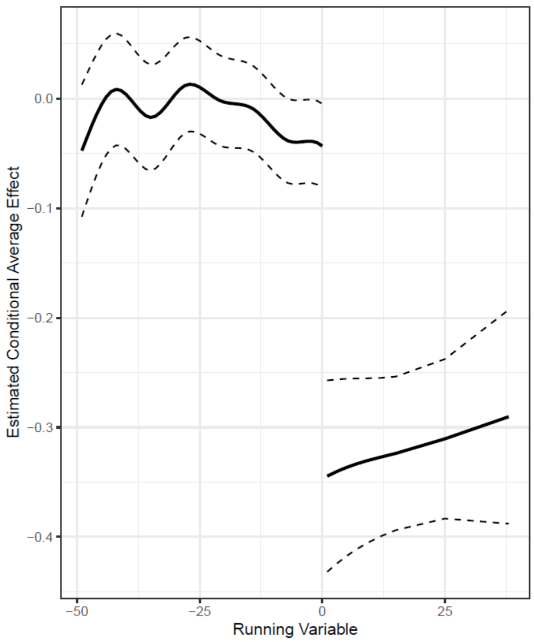
(D) Attained a 2- or 4-Year College Degree



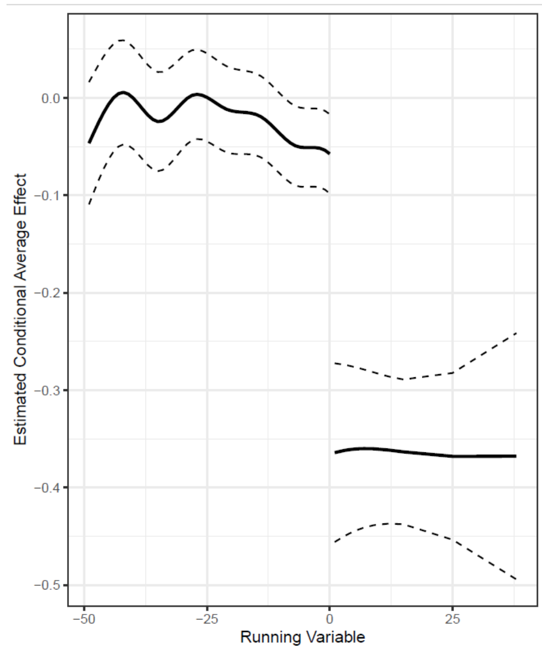
Notes: The figure presents the raw cell means of the averaged postsecondary outcomes (residualized using the student characteristics included in Table 3 along with grade-by-year fixed-effects) for each reading score between 20 points below and 20 points above the remediation cutoff. The solid lines represent the linear fit estimated separately for the left of the cutoff score and the right. All panels exclude district/sector switchers.

Figure 5. Conditional Average Treatment Effects on Postsecondary Outcomes by Student Reading Achievement in Previous Year

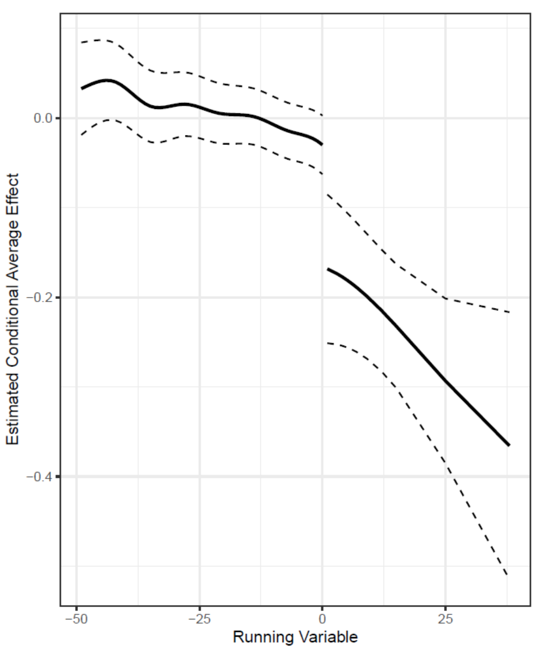
(A) Enrolled in a 2- or 4-Year College



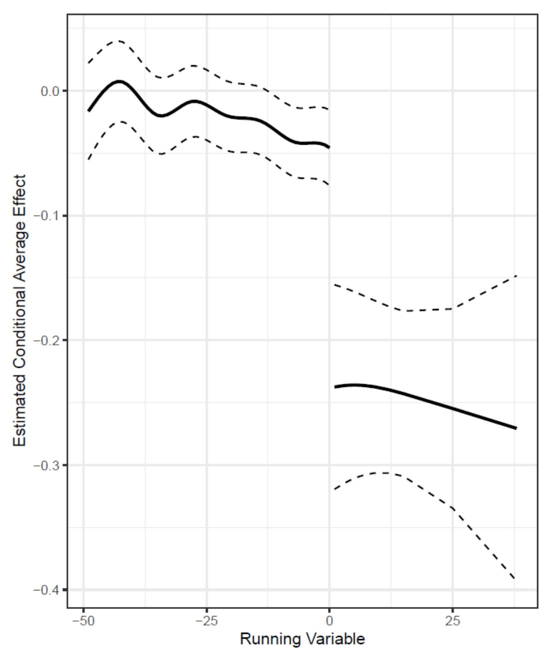
(B) Enrolled in a 4-Year College



(C) Enrolled in a “Very Competitive” College

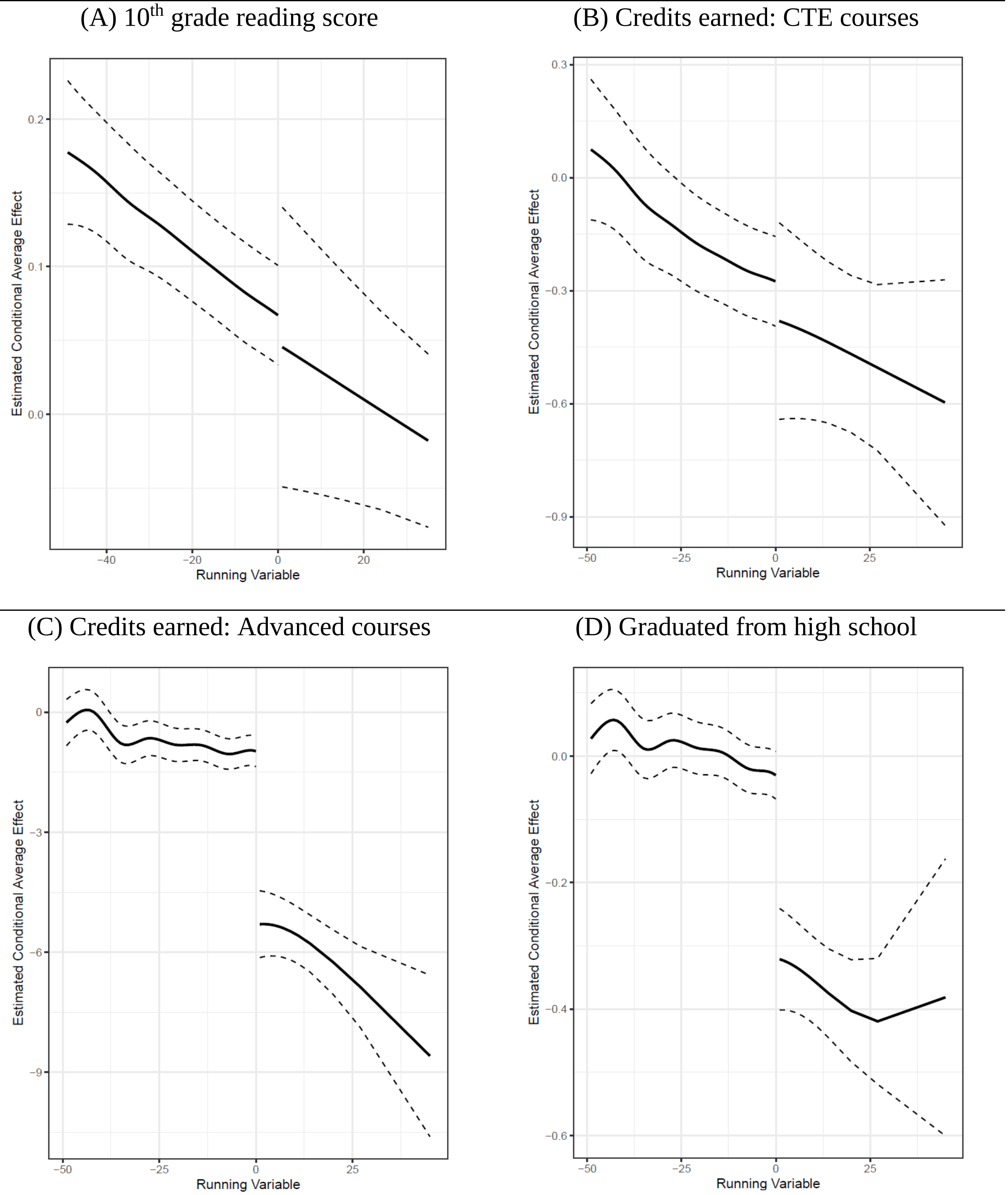


(D) Attained a 2- or 4-Year College Degree



Notes: The figure plots how the conditional average treatment effect on the treated varies with the running variable for postsecondary outcomes. The dashed lines indicate the 95% confidence interval, estimated via a Bayesian bootstrap with school-level clustering. All panels exclude district/sector switchers.

Figure 6. Conditional Average Treatment Effects on High School Outcomes by Student Reading Achievement in Previous Year



Notes: The figure plots how the conditional average treatment effect on the treated varies with the running variable for high school outcomes. The dashed lines indicate the 95% confidence interval, estimated via a Bayesian bootstrap with school-level clustering. All panels exclude district/sector switchers.

Table 1. Student Characteristics by Remediation Status in ELA

	All students		RD sample		RD sample – Below the cutoff	
	No remedial schedule	Remedial schedule	No remedial schedule	Remedial schedule	No remedial schedule	Remedial schedule
Student characteristics in prior years						
8^{th} grade math score	0.364	-0.530	0.161	-0.0953	-0.028	-0.095
	(0.874)	(0.852)	(0.579)	(0.571)	(0.577)	(0.571)
ELA score two years prior	0.378	-0.587	0.128	-0.141	-0.096	-0.143
	(0.910)	(0.742)	(0.514)	(0.482)	(0.497)	(0.480)
Prior year disciplinary incident	0.275	0.466	0.328	0.377	0.395	0.371
	(0.446)	(0.499)	(0.469)	(0.485)	(0.489)	(0.483)
Prior year absence rate	0.047	0.061	0.049	0.054	0.054	0.053
	(0.050)	(0.061)	(0.050)	(0.054)	(0.055)	(0.053)
Took a remedial ELA course in prior year	0.114	0.505	0.152	0.317	0.225	0.315
	(0.318)	(0.500)	(0.359)	(0.465)	(0.418)	(0.464)
Took a remedial math course in prior year	0.0295	0.110	0.0339	0.059	0.052	0.059
	(0.169)	(0.312)	(0.181)	(0.236)	(0.221)	(0.235)
Took an advanced course in prior year	0.433	0.097	0.287	0.166	0.204	0.168
	(0.495)	(0.296)	(0.452)	(0.372)	(0.403)	(0.373)
Special education in prior year	0.076	0.224	0.0815	0.121	0.103	0.119
	(0.265)	(0.417)	(0.274)	(0.326)	(0.304)	(0.323)
Other student characteristics						
Eligible for subsidized meals	0.469	0.688	0.534	0.626	0.590	0.623
	(0.499)	(0.463)	(0.499)	(0.484)	(0.492)	(0.485)
White	0.387	0.207	0.333	0.253	0.287	0.254
	(0.487)	(0.405)	(0.471)	(0.435)	(0.452)	(0.435)
Black	0.207	0.393	0.256	0.310	0.298	0.308
	(0.405)	(0.488)	(0.436)	(0.463)	(0.458)	(0.462)
Hispanic	0.317	0.346	0.334	0.366	0.346	0.366
	(0.465)	(0.476)	(0.472)	(0.482)	(0.476)	(0.482)
Male	0.492	0.517	0.493	0.493	0.499	0.491
	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)	(0.500)
English not native	0.332	0.329	0.331	0.336	0.379	0.335
	(0.471)	(0.470)	(0.471)	(0.472)	(0.485)	(0.472)
N	49,087	20,981	19,023	6,713	5,947	6,555

Notes: Standard deviations are given in parentheses. Test scores are standardized at the grade-year level to zero mean and unit variance. The first two columns present summary statistics for all students in the study sample whereas the third and fourth columns use students in the RD sample (students within 20 points around the remediation cutoff), and the fifth and sixth columns use students right below the cutoff (within 20 points below the cutoff) by ELA remediation status.

Table 2. Student Outcomes by Remediation Status in ELA

	All students		RD sample		RD sample – Below the cutoff	
	No remedial schedule	Remedial schedule	No remedial schedule	Remedial schedule	No remedial schedule	Remedial schedule
Year of remediation						
Took a remedial math course	0.027	0.140	0.029	0.078	0.036	0.075
	(0.162)	(0.347)	(0.168)	(0.266)	(0.187)	(0.264)
Took an advanced course	0.478	0.162	0.399	0.260	0.317	0.264
	(0.500)	(0.369)	(0.490)	(0.439)	(0.465)	(0.441)
High school outcomes						
Took a CTE course	0.656	0.569	0.694	0.622	0.688	0.623
	(0.475)	(0.495)	(0.461)	(0.485)	(0.463)	(0.485)
CTE credits earned	1.453	0.999	1.537	1.186	1.462	1.189
	(1.624)	(1.341)	(1.626)	(1.453)	(1.561)	(1.452)
Advanced course credits earned	8.013	2.499	6.431	4.284	4.772	4.347
	(5.844)	(3.797)	(5.274)	(4.561)	(4.887)	(4.571)
Ever took a college-credit bearing course	0.557	0.159	0.429	0.290	0.291	0.294
	(0.497)	(0.365)	(0.495)	(0.454)	(0.454)	(0.456)
10^{th} grade reading score	0.334	-0.398	0.126	-0.074	-0.0279	-0.0759
	(0.859)	(0.642)	(0.535)	(0.492)	(0.498)	(0.493)
Graduated from high school	0.750	0.527	0.748	0.683	0.694	0.689
	(0.433)	(0.499)	(0.434)	(0.465)	(0.461)	(0.463)
Postsecondary outcomes						
Enrolled in any college	0.636	0.378	0.608	0.526	0.544	0.532
	(0.481)	(0.485)	(0.488)	(0.499)	(0.498)	(0.499)
Enrolled in a 4-year institution	0.602	0.340	0.565	0.482	0.493	0.488
	(0.489)	(0.474)	(0.496)	(0.500)	(0.500)	(0.500)
Enrolled in a highly competitive institution	0.373	0.108	0.277	0.187	0.209	0.189
	(0.484)	(0.311)	(0.448)	(0.390)	(0.407)	(0.392)
Persisted beyond second year	0.529	0.259	0.477	0.377	0.412	0.382
	(0.499)	(0.438)	(0.499)	(0.485)	(0.492)	(0.486)
Received a 2-year or 4-year degree	0.388	0.146	0.320	0.233	0.254	0.236
	(0.487)	(0.353)	(0.466)	(0.422)	(0.435)	(0.424)
N	49,087	20,981	19,023	6,713	5,947	6,555

Notes: Standard deviations are given in parentheses. Test scores are standardized at the grade-year level to zero mean and unit variance. The first two columns present summary statistics for all students in the study sample whereas the third and fourth columns use students in the RD sample (students within 20 points around the remediation cutoff), and the fifth and sixth columns use students right below the cutoff (within 20 points below the cutoff) by ELA remediation status.

Table 3. Baseline Equivalency of Student Characteristics around the Remediation Cutoff

		Excluding district/sector switchers
Student characteristics in prior years		
8th grade math score	0.027*	0.028**
	(0.014)	(0.014)
ELA score two years prior	0.009	0.010
	(0.011)	(0.012)
Prior year disciplinary incident	0.008	0.016
	(0.012)	(0.012)
	[0.340]	[0.319]
Prior year absence rate	0.001	0.002
	(0.001)	(0.001)
	[0.051]	[0.047]
Took a remedial ELA course in prior year	-0.007	-0.002
	(0.009)	(0.010)
	[0.190]	[0.180]
Took a remedial math course in prior year	0.002	0.001
	(0.005)	(0.005)
	[0.033]	[0.036]
Took an advanced course in prior year	0.009	0.004
	(0.010)	(0.011)
	[0.206]	[0.220]
Special education in prior year	0.008	0.009
	(0.007)	(0.007)
	[0.089]	[0.088]
Other student characteristics		
Eligible for subsidized meals	0.003	-0.004
	(0.012)	(0.013)
	[0.565]	[0.565]
White	0.007	0.005
	(0.011)	(0.012)
	[0.313]	[0.311]
Black	-0.008	-0.010
	(0.011)	(0.012)
	[0.273]	[0.267]
Hispanic	0.005	0.005
	(0.012)	(0.012)
	[0.338]	[0.339]
Male	0.003	0.003
	(0.012)	(0.013)
	[0.480]	[0.469]
English not native	0.011	0.008
	(0.012)	(0.012)
	[0.325]	[0.334]
Test of joint significance		
F-stat	0.77	0.82
p-value	0.699	0.653
Number of students	26,007	23,182

Notes: Robust standard errors 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 20 points. The numbers in brackets represent the dependent variable mean right above the cutoff. *, **, and *** represent statistical significance at 10, 5, and 1 percent, respectively.

Table 4. Effects of Remediation on Educational Inputs by Subject, Remediation Year

	ELA	Other core courses	Electives
Time spent (minutes per week)	300.385***	35.522	-253.391***
	(14.780)	(30.729)	(38.285)
	[356.3]	[734.5]	[975.8]
Teacher experience (in years)	-0.251	-0.956**	0.109
	(0.554)	(0.479)	(0.507)
	[8.587]	[9.114]	[10.92]
Teacher experience: 0-2 years	0.036	0.042**	0.010
	(0.024)	(0.021)	(0.016)
	[0.119]	[0.136]	[0.098]
Teacher value-added in ELA	0.006***		
	(0.001)		
	[0.018]		
Class size	-2.832***	0.004	-0.187
	(0.391)	(0.272)	(0.358)
	[24.05]	[22.92]	[21.38]
Classroom-peer prior test scores	-0.524***	-0.150***	-0.066**
	(0.038)	(0.035)	(0.029)
First stage	0.352***	0.352***	0.352***
	(0.010)	(0.010)	(0.010)
N	20,212	20,212	20,212

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 are given in parentheses. The estimates represent the treatment effect (β) on the corresponding outcome obtained using linear polynomial specification and a bandwidth of 20 points. For all outcomes other than teacher value-added scores, the numbers in brackets represent the dependent variable mean right above the cutoff; For teacher value-added scores, the number in brackets provides the standard deviation. 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 courses in each category the student takes in a given school year. Classroom-peer prior test scores is the averaged prior reading and math scores of all classroom peers of the student. *, **, and *** represent statistical significance at 10, 5, and 1 percent, respectively.

Table 5. Effects of Remediation on Course-taking, Remediation Year

Electives	
CTE	-0.191***
	(0.027)
	[0.354]
Music	-0.022
	(0.022)
	[0.189]
Physical education	-0.057***
	(0.022)
	[0.214]
Arts	-0.127***
	(0.023)
	[0.227]
Drama	-0.061***
	(0.016)
	[0.103]
World languages	-0.182***
	(0.026)
	[0.597]
Advanced courses in core subjects	
ELA	-0.154***
	(0.025)
	[0.518]
Math	-0.032
	(0.024)
	[0.351]
Science	-0.073***
	(0.025)
	[0.451]
Social studies	-0.157***
	(0.026)
	[0.413]
Non-remedial subjects - overall	-0.096***
	(0.025)
	[0.605]
N	25,736

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 are given in parentheses. The estimates represent the treatment effect (β) on the corresponding outcome obtained using linear polynomial specification and a bandwidth of 20 points. The numbers in brackets represent the dependent variable mean right above the cutoff. *, **, and *** represent statistical significance at 10, 5, and 1 percent, respectively.

Table 6. Effects of Remediation on High School Outcomes

		Excluding district/sector switchers
Elective course-taking		
Took a CTE course	-0.069**	-0.069**
	(0.027)	(0.028)
	[0.692]	[0.705]
Credits earned: CTE	-0.245***	-0.253***
	(0.090)	(0.098)
	[1.459]	[1.519]
CTE participant	-0.068**	-0.065**
	(0.028)	(0.029)
	[0.645]	[0.658]
Advanced course-taking in core subjects		
Credits earned: advanced courses	-0.852***	-0.903***
	(0.235)	(0.251)
	[6.232]	[6.735]
Credits earned: advanced courses – other core subjects	-0.544***	-0.568***
	(0.175)	(0.188)
	[4.381]	[4.736]
Took a college credit-bearing course	-0.076***	-0.071***
	(0.025)	(0.027)
	[0.420]	[0.461]
Took a college credit-bearing course – other core subjects	-0.069***	-0.062**
	(0.025)	(0.027)
	[0.397]	[0.434]
Reading achievement		
10^{th} grade reading score – first try	0.065***	0.060**
	(0.024)	(0.024)
Passed 10^{th} grade reading test – first try	0.037**	0.034*
	(0.019)	(0.020)
	[0.136]	[0.137]
Cumulative GPA	0.026	0.038
	(0.026)	(0.026)
	[2.671]	[2.715]
Ever suspended	0.007	-0.001
	(0.025)	(0.027)
	[0.571]	[0.558]
% absent days	0.004	0.006*
	(0.004)	(0.003)
	[0.070]	[0.062]
Graduated from high school	-0.033	-0.049**
	(0.024)	(0.022)
	[0.754]	[0.853]
First stage	0.423***	0.422***
	(0.009)	(0.009)
	25,736	22,988

Notes: This table reports 2SLS estimates of the impact of taking a remedial ELA course on high school outcomes using equations (1) and (2). Robust standard errors are given in parentheses. The estimates represent the treatment effect (β) on the corresponding outcome obtained using linear polynomial specification and a bandwidth of 20 points. The numbers in brackets represent the dependent variable mean right above the cutoff. *, **, and *** represent statistical significance at 10, 5, and 1 percent, respectively.

Table 7. Effects of Remediation on Postsecondary Outcomes

		Excluding district/sector switchers
Enrollment		
Ever enrolled	-0.032	-0.045
	(0.027)	(0.028)
	[0.637]	[0.721]
Ever enrolled in a 2-year institution	-0.009	-0.021
	(0.023)	(0.025)
	[0.257]	[0.290]
Ever enrolled in a 4-year institution	-0.042	-0.053*
	(0.027)	(0.028)
	[0.606]	[0.686]
Ever enrolled in a highly competitive institution	-0.044*	-0.053**
	(0.023)	(0.026)
	[0.268]	[0.304]
Persistence and completion		
Enrolled beyond first year	-0.041	-0.053*
	(0.027)	(0.029)
	[0.543]	[0.614]
Enrolled beyond second year	-0.056**	-0.070**
	(0.027)	(0.029)
	[0.491]	[0.556]
Obtained a 2-year or 4-year degree	-0.051**	-0.062**
	(0.025)	(0.027)
	[0.316]	[0.357]
Obtained a 2-year degree	-0.049**	-0.059**
	(0.023)	(0.026)
	[0.235]	[0.265]
Obtained a 4-year degree	-0.052**	-0.063**
	(0.025)	(0.027)
	[0.307]	[0.347]
First stage	0.423***	0.422***
	(0.009)	(0.009)
	25,736	22,988

Notes: This table reports 2SLS estimates of the impact of taking a remedial ELA course on postsecondary outcomes using equations (1) and (2). Robust standard errors are given in parentheses. The estimates represent the treatment effect (β) on the corresponding outcome obtained using linear polynomial specification and a bandwidth of 20 points. The numbers in brackets represent the dependent variable mean right above the cutoff. *, **, and *** represent statistical significance at 10, 5, and 1 percent, respectively.

Table 8. Mediation Analysis: Postsecondary Effects of High School Remediation

Postsecondary outcomes	(I)	(II)
Ever enrolled	-0.032	0.007
	(0.027)	(0.020)
Ever enrolled in a 4-year institution	-0.042	-0.002
	(0.027)	(0.021)
Ever enrolled in a highly competitive institution	-0.044*	-0.018
	(0.023)	(0.022)
Enrolled beyond second year	-0.056**	-0.015
	(0.027)	(0.024)
Obtained a 2-year or 4-year degree	-0.051**	-0.021
	(0.025)	(0.024)
N	25,736	24,170
	Excluding district/sector switchers	
Ever enrolled	-0.045	0.007
	(0.028)	(0.022)
Ever enrolled in a 4-year institution	-0.053*	-0.002
	(0.028)	(0.024)
Ever enrolled in a highly competitive institution	-0.053**	-0.022
	(0.026)	(0.025)
Enrolled beyond second year	-0.070**	-0.018
	(0.029)	(0.026)
Obtained a 2-year or 4-year degree	-0.062**	-0.024
	(0.027)	(0.026)
Controlling for high school outcomes	No	Yes
N	22,988	22,116

Notes: This table reports 2SLS estimates of the impact of taking a remedial ELA course on postsecondary outcomes in Table 6 using equations (1) and (2). Robust standard errors are given in parentheses. The estimates represent the treatment effect (β) on the corresponding outcome obtained using linear polynomial specification and a bandwidth of 20 points. Column (II) introduces the high school outcomes listed in Table 6 as covariates. *, **, and *** represent statistical significance at 10, 5, and 1 percent, respectively.

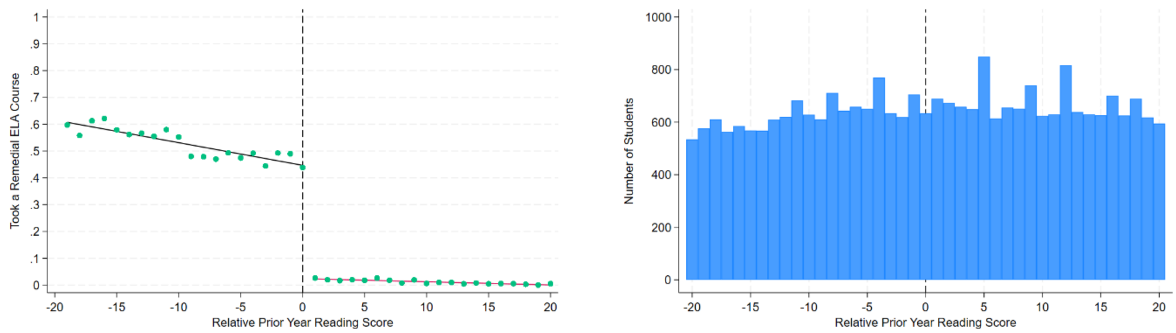
Table 9. Estimated Effects on High School and Postsecondary Outcomes by Prior ELA Achievement

			Excluding district/sector switchers	
	Not proficient two years prior	Proficient two years prior	Not proficient two years prior	Proficient two years prior
High school outcomes				
10th grade reading score – first try	0.075*	0.074**	0.074*	0.073**
	(0.042)	(0.029)	(0.045)	(0.029)
Passed 10th grade reading test – first try	0.040	0.048*	0.049*	0.039
	(0.027)	(0.024)	(0.029)	(0.026)
Took a CTE course	-0.044	-0.100***	-0.048	-0.101***
	(0.048)	(0.034)	(0.050)	(0.035)
CTE credit earned	-0.198	-0.299***	-0.243	-0.294**
	(0.151)	(0.116)	(0.166)	(0.125)
Advanced course credit earned	-0.729*	-0.779**	-0.889**	-0.772**
	(0.389)	(0.304)	(0.427)	(0.321)
Advanced course credit earned – other core subjects	-0.418	-0.516**	-0.503	-0.503**
	(0.289)	(0.227)	(0.317)	(0.241)
Took a college credit-bearing course	-0.018	-0.094***	-0.020	-0.086**
	(0.042)	(0.033)	(0.046)	(0.035)
Took a college credit-bearing course – other core subjects	-0.027	-0.082**	-0.026	-0.072**
	(0.041)	(0.033)	(0.045)	(0.035)
Received a high school diploma	-0.029	-0.044	-0.052	-0.058**
	(0.044)	(0.030)	(0.043)	(0.027)
College outcomes				
Enrolled in a 4-year college	-0.065	-0.017	-0.087*	-0.024
	(0.048)	(0.034)	(0.052)	(0.035)
Enrolled in a highly selective college	-0.005	-0.049	-0.015	-0.056*
	(0.037)	(0.031)	(0.042)	(0.033)
Persisted beyond second year	-0.020	-0.062*	-0.038	-0.073**
	(0.047)	(0.034)	(0.051)	(0.036)
Attained a 2- or 4-year degree	0.002	-0.063**	-0.009	-0.072**
	(0.041)	(0.032)	(0.045)	(0.035)
First stage	0.448***	0.406***	0.446***	0.406***
	(0.015)	(0.011)	(0.016)	(0.011)
N	8,262	17,474	7,219	15,769

Notes: All regressions control for the baseline student characteristics listed in Table 3, and robust standard errors are given in parentheses. This table reports fuzzy RD estimates of the impact of taking a remedial ELA course on high school and postsecondary outcomes based on whether the student scored above the proficiency cutoff on the ELA test two years prior. *, **, and *** represent statistical significance at 10, 5, and 1 percent, respectively.

Appendix Figure 1. Likelihood of Taking a Remedial ELA Course and Prior Year Reading Score Density Around the Remediation Cutoff

(A) Took a Remedial ELA Course (B) Prior Year ELA Score Density

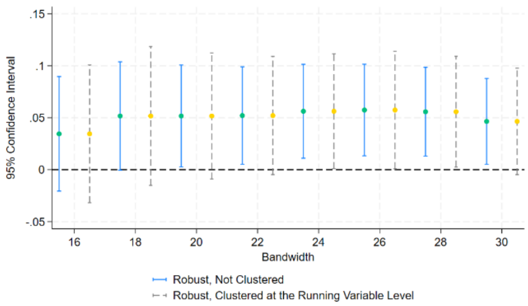


Notes: Panel (A) presents the raw cell means of the remediation indicator for each prior year ELA score between 20 points below and 20 points above the remediation cutoff. Panel (B) presents the density of the running variable (prior year reading score) centered at the remediation cutoff.

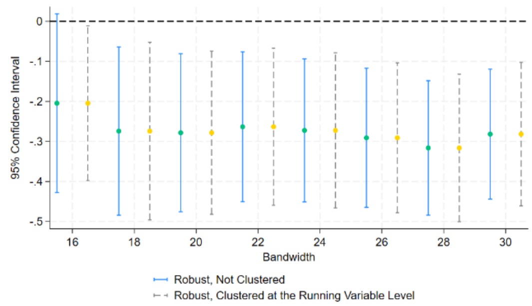
Appendix Figure 2. Robustness to Bandwidth Selection and Standard Error Clustering

(I) High School Outcomes

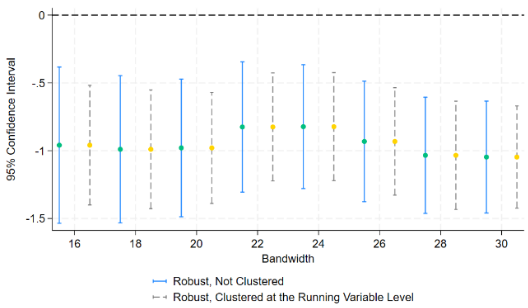
(A) 10th grade reading scores



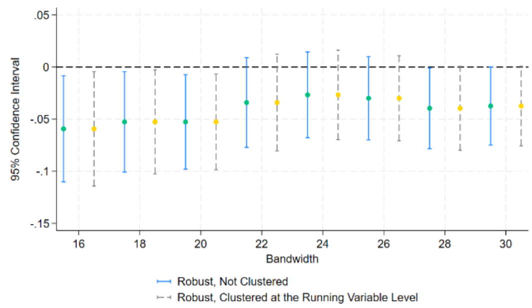
(B) CTE credits earned



(C) Credits earned in advanced courses

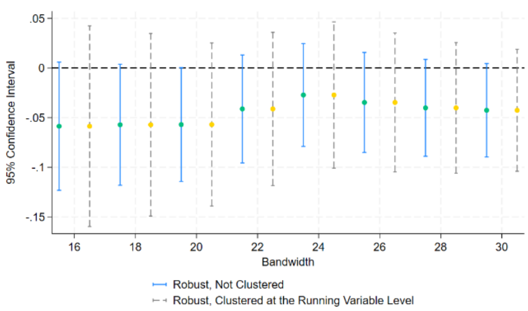


(D) High school diploma

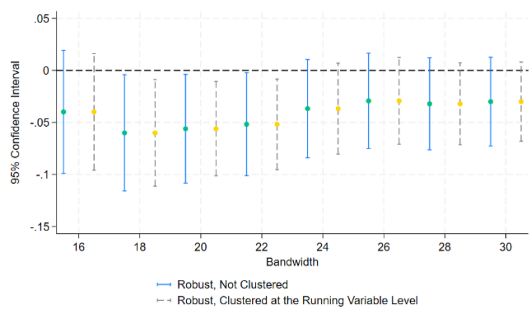


(II) College Outcomes

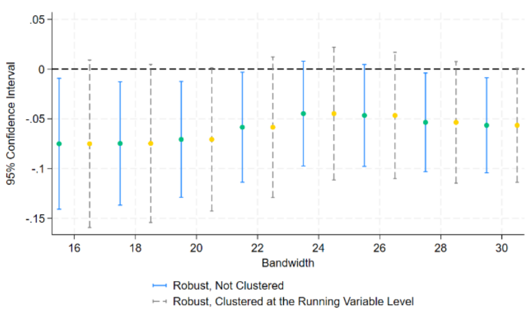
(A) Enrolled in a 4-year college



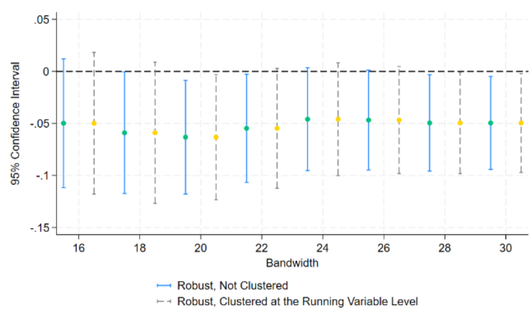
(B) Enrolled in a highly selective college



(C) Persisted beyond second year



(D) Attained a 2- or 4-year college degree



Notes: The figures present the effects of being placed in the remedial schedule in high school on high school and postsecondary outcomes and the 95% confidence interval estimated using the bandwidth shown and linear specification, with robust standard errors clustered at the prior year reading score level (dashed line) and not clustered (solid line).

Appendix Table 1. Student Characteristics by Attrition Status

	Did not leave LUSD in high school	Left LUSD in high school
Student characteristics in prior years		
8th grade math score	0.149	-0.363
	(0.943)	(0.995)
ELA score two years prior	0.138	-0.332
	(0.956)	(0.983)
Prior year disciplinary incident	0.309	0.535
	(0.462)	(0.499)
Prior year absence rate	0.048	0.082
	(0.052)	(0.073)
Took a remedial ELA course in prior year	0.216	0.360
	(0.412)	(0.480)
Took a remedial math course in prior year	0.050	0.090
	(0.218)	(0.287)
Took an advanced course in prior year	0.353	0.160
	(0.478)	(0.366)
Special education in prior year	0.113	0.188
	(0.316)	(0.391)
Other student characteristics		
Eligible for subsidized meals	0.518	0.665
	(0.500)	(0.472)
White	0.336	0.300
	(0.472)	(0.458)
Black	0.262	0.286
	(0.440)	(0.452)
Hispanic	0.320	0.368
	(0.466)	(0.482)
Male	0.492	0.558
	(0.500)	(0.497)
English not native	0.324	0.397
	(0.468)	(0.489)
N	62,564	8,437

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

Appendix Table 2. Robustness of Main Findings to Optimal Bandwidth

		Excluding district/sector switchers
High school outcomes		
10th grade reading score – first try	0.076**	0.082***
	(0.030)	(0.028)
Optimal bandwidth	22.81	29
Passed 10th grade reading test – first try	0.045**	0.046**
	(0.021)	(0.023)
Optimal bandwidth	23	23.43
Took a CTE course	-0.088***	-0.083***
	(0.031)	(0.031)
Optimal bandwidth	21.94	24.23
CTE credit earned	-0.242**	-0.258**
	(0.104)	(0.108)
Optimal bandwidth	21.49	23.95
Advanced course credit earned	-0.975***	-0.976***
	(0.284)	(0.292)
Optimal bandwidth	20.91	22.98
Advanced course credit earned – other core subjects	-0.679***	-0.670***
	(0.213)	(0.223)
	20.68	22.27
Took a college credit-bearing course	-0.079***	-0.074**
	(0.030)	(0.031)
Optimal bandwidth	20.75	23.61
Took a college credit-bearing course – other core subjects	-0.072**	-0.064**
	(0.030)	(0.030)
	20.95	23.61
Received a high school diploma	-0.038	-0.057**
	(0.028)	(0.025)
Optimal bandwidth	21.54	24.24
College outcomes		
Enrolled in a 2- or 4-year college	-0.037	-0.049
	(0.030)	(0.030)
Optimal bandwidth	22.29	24.84
Enrolled in a 4-year college	-0.050	-0.061**
	(0.031)	(0.031)
Optimal bandwidth	22.20	23.94
Enrolled in a highly selective college	-0.051*	-0.060**
	(0.027)	(0.029)
Optimal bandwidth	21.52	23.10
Persisted beyond second year	-0.064**	-0.077**
	(0.031)	(0.032)
Optimal bandwidth	22.35	23.79
Attained a 2- or 4-year degree	-0.043*	-0.053*
	(0.026)	(0.028)
Optimal bandwidth	26.80	26.80

Notes: All regressions control for the baseline student characteristics listed in Table 3, and robust standard errors are given in parentheses. This table reports fuzzy RD estimates of the impact of taking a remedial ELA course on high school and postsecondary outcomes obtained non-parametrically using the optimal bandwidth procedure developed by Calonico et al. (2017). *, **, and *** represent statistical significance at 10, 5, and 1 percent, respectively.

Appendix Table 3. Estimated Effects of High School Remediation: Reduced-Form

		Excluding district/sector switchers
High school outcomes		
10^{th} grade reading score – first try	0.029***	0.026**
	(0.010)	(0.010)
Passed 10^{th} grade reading test – first try	0.017**	0.015*
	(0.008)	(0.008)
	[0.136]	[0.137]
Took a CTE course	-0.029**	-0.029**
	(0.011)	(0.012)
	[0.692]	[0.705]
CTE credit earned	-0.102***	-0.107***
	(0.038)	(0.041)
	[1.459]	[1.519]
Advanced course credit earned	-0.338***	-0.369***
	(0.099)	(0.105)
	[6.232]	[6.735]
Advanced course credit earned – other core subjects	-0.214***	-0.230***
	(0.074)	(0.079)
	[4.314]	[4.693]
Took a college credit-bearing course	-0.031***	-0.030***
	(0.011)	(0.011)
	[0.420]	[0.461]
Took a college credit-bearing course – other core subjects	-0.028***	-0.026**
	(0.010)	(0.011)
	[0.390]	[0.430]
Received a high school diploma	-0.010	-0.018*
	(0.010)	(0.010)
	[0.754]	[0.853]
College outcomes		
Enrolled in a 2- or 4-year college	-0.015	-0.021*
	(0.011)	(0.012)
	[0.637]	[0.721]
Enrolled in a 4-year college	-0.018*	-0.022**
	(0.010)	(0.011)
	[0.606]	[0.686]
Enrolled in a highly selective college	-0.022**	-0.029**
	(0.011)	(0.012)
	[0.268]	[0.304]
Persisted beyond second year	-0.021**	-0.026**
	(0.010)	(0.011)
	[0.491]	[0.556]
Attained a 2- or 4-year degree	-0.021**	-0.026**
	(0.010)	(0.011)
	[0.316]	[0.357]
N	25,736	22,988

Notes: All regressions control for the baseline student characteristics listed in Table 2, and robust standard errors are given in parentheses. This table reports fuzzy RD estimates of the impact of taking a remedial ELA course on high school and postsecondary outcomes obtained non-parametrically using the optimal bandwidth procedure developed by Calonico et al. (2017). *, **, and *** represent statistical significance at 10, 5, and 1 percent, respectively.

Appendix Table 4. Effects of Remediation on Postsecondary Outcomes: Robustness to Attrition

	Assign district/sector switchers…		
	Worse outcome	Predicted outcome	Better outcome
Enrollment			
Ever enrolled	-0.032	-0.040	-0.045
	(0.027)	(0.025)	(0.028)
	[0.637]	[0.701]	[0.721]
Ever enrolled in a 2-year institution	-0.009	-0.012	-0.021
	(0.023)	(0.022)	(0.025)
	[0.257]	[0.284]	[0.290]
Ever enrolled in a 4-year institution	-0.042	-0.049*	-0.053*
	(0.027)	(0.025)	(0.028)
	[0.606]	[0.665]	[0.686]
Ever enrolled in a highly competitive institution	-0.044*	-0.048**	-0.053**
	(0.023)	(0.023)	(0.026)
	[0.268]	[0.296]	[0.304]
Persistence and completion			
Enrolled beyond first year	-0.041	-0.048*	-0.053*
	(0.027)	(0.026)	(0.029)
	[0.543]	[0.597]	[0.614]
Enrolled beyond second year	-0.056**	-0.063**	-0.070**
	(0.027)	(0.026)	(0.029)
	[0.491]	[0.539]	[0.556]
Obtained a 2-year or 4-year degree	-0.051**	-0.055**	-0.062**
	(0.025)	(0.024)	(0.027)
	[0.316]	[0.347]	[0.357]
Obtained a 2-year degree	-0.049**	-0.051**	-0.059**
	(0.023)	(0.023)	(0.026)
	[0.235]	[0.255]	[0.265]
Obtained a 4-year degree	-0.052**	-0.057**	-0.063**
	(0.025)	(0.024)	(0.027)
	[0.307]	[0.337]	[0.347]
First stage	0.423***	0.423***	0.423***
	(0.009)	(0.009)	(0.009)
N	25,736	25,736	25,736

Notes: This table reports 2SLS estimates of the impact of taking a remedial ELA course on postsecondary outcomes using equations (1) and (2). Robust standard errors are given in parentheses. The estimates represent the treatment effect (β) on the corresponding outcome obtained using linear polynomial specification and a bandwidth of 20 points. The numbers in brackets represent the dependent variable mean right above the cutoff. The first column assigns the worse outcome (zero); the second column assigns the predicted outcome; and the third column assigns the better outcome (one) to students who left the district or switched to a private school. Predicted outcomes are obtained using the baseline characteristics/outcomes listed in Table 3. *, **, and *** represent statistical significance at 10, 5, and 1 percent, respectively.

Appendix Table 5. Mediation Analysis: College Enrollment and Graduation Effects of High School Remediation

	Outcome: Enrolled in a highly competitive college	
Mediator	(I)	(II)
10th grade ELA score	-0.044*	-0.051**
	(0.023)	(0.024)
Credits earned in advanced courses in high school	-0.044*	-0.014
	(0.023)	(0.022)
Credits earned in CTE courses in high school	-0.044*	-0.042*
	(0.023)	(0.024)
Graduated from high school	-0.044*	-0.035
	(0.023)	(0.023)
	Outcome: Enrolled beyond second year	
Mediator	(I)	(II)
10th grade ELA score	-0.056**	-0.060**
	(0.027)	(0.027)
Credits earned in advanced courses in high school	-0.056**	-0.020
	(0.027)	(0.025)
Credits earned in CTE courses in high school	-0.056**	-0.050*
	(0.027)	(0.027)
Graduated from high school	-0.056**	-0.039*
	(0.027)	(0.024)
	Outcome: Obtained a 2- or 4-Year College Degree	
Mediator	(I)	(II)
10th grade ELA score	-0.051**	-0.055**
	(0.025)	(0.025)
Credits earned in advanced courses in high school	-0.051**	-0.021
	(0.025)	(0.023)
Credits earned in CTE courses in high school	-0.051**	-0.047*
	(0.025)	(0.025)
Graduated from high school	-0.051**	-0.040*
	(0.025)	(0.023)
Mediator included	No	Yes

Notes: This table reports 2SLS estimates of the impact of taking a remedial ELA course on postsecondary outcomes in Table 7 using equations (1) and (2). Robust standard errors are given in parentheses. The estimates represent the treatment effect (β) on the corresponding outcome obtained using linear polynomial specification and a bandwidth of 20 points. Column (II) introduces the high school outcomes listed in the first column as covariates. *, **, and *** represent statistical significance at 10, 5, and 1 percent, respectively.