The Impact of Reading Apprenticeship in North Carolina on Student Course Grades

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Introduction

Schools in rural North Carolina face significant literacy challenges, particularly in low-wealth districts. In 2019, students in rural districts in North Carolina had significantly lower ELA test scores in grade 8 when compared with students in non-rural districts. Likewise, students facing economic barriers in these rural districts performed nearly half a standard deviation below the national average, and significantly lower than students facing socioeconomic barriers in non-rural districts in North Carolina (SEDA, 2025).

Reading Apprenticeship (RA) seeks to improve the academic achievement of high school students in rural, low-wealth North Carolina districts by providing evidence-based professional learning with a disciplinary literacy focus to teachers, as well as integrated supports to ensure high-quality implementation of RA routines. RA is both a professional development model and an instructional framework. The instructional framework focuses on four interacting dimensions of learning that are developed through extensive reading and metacognitive conversation: building a collaborative classroom, building on student strengths, building reading skills, and building content knowledge (Greenleaf et al., 2023). RA has previously been shown to improve student reading comprehension, subject-area knowledge, and disciplinary literacy (Fancsali et al., 2015; Goldman, et al., 2019; Somers et al., 2010) The intensive and sustained RA professional learning, which for the North Carolina schools, was implemented for two consecutive years, includes:

- Annual meetings of instructional and administrative leaders that support the integration of RA into districts' core practices,
- Blended professional learning for all 9th and 10th grade ELA, social studies, and science teachers over two school years (82 hours),
- Leadership training for teacher leaders (50 hours) to support implementation and sustain the effective use of RA in focus districts, and
- Preparation of teacher-leaders to become certified RA facilitators to further expand RA in North Carolina and beyond.

Funded by an Education, Innovation, and Research (EIR) Mid-Phase grant, WestEd and SRI Education partnered to study the implementation and impact of RA in North Carolina schools. The study of Reading Apprenticeship in North Carolina took place from 2021-22 through 2024-25 and ultimately included four cohorts of treatment schools. In this report, we use data from the first two cohorts (Cohort A and Cohort B) during the school years 2021-22, 2022-23, and 2023-24 to address one main research question:

- What is the impact of one year of RA on students' literacy, social studies, and science course grades, as compared to business as usual?

Methods

SRI's study design uses the information we have on schools that implemented RA to identify a similar group of schools to which we can compare them. We contrast the performance of students in treatment and comparison schools to estimate the impact of Reading Apprenticeship on student course grades after one year of exposure to RA.

Data and Measures

The data for this study come from the North Carolina Education Research Data Center (NCERDC), which houses statewide student, course, teacher, and school data. The analysis focuses on how RA professional learning and supports impacted student course grades in social studies, science, and English Language Arts (ELA). The way that schools and districts collected and reported course grades varied by location, so we transformed the data and put all grades on a common scale. The scale was five points, ranging from 0 to 4, where each point was equivalent to a letter grade (4 = A, 3 = B, 2 = C, 1 = D, 0 = F). See Appendix A for the course grade values as recorded and how they were converted to this scale.

In addition to course grades, we also collected data from NCERDC to identify comparison schools and to account for pre-existing differences between the treatment and comparison conditions. These data included:

- **Student variables:** baseline achievement, race/ethnicity, gender, special education status, English learner status, and socioeconomic status (flagged as "low-income")
- **Teacher variables**: highest degree earned, years of teaching experience, certification in the grade level of the outcome (grade 9 or 10), and certification in the subject area of the outcome (social studies, science, or ELA)
- **Classroom variables**: Course type (standard, honors, Advanced Placement, International Baccalaureate) and course format (regular, virtual)
- **School variables:** School-level percentages of all student-level variables

Sample

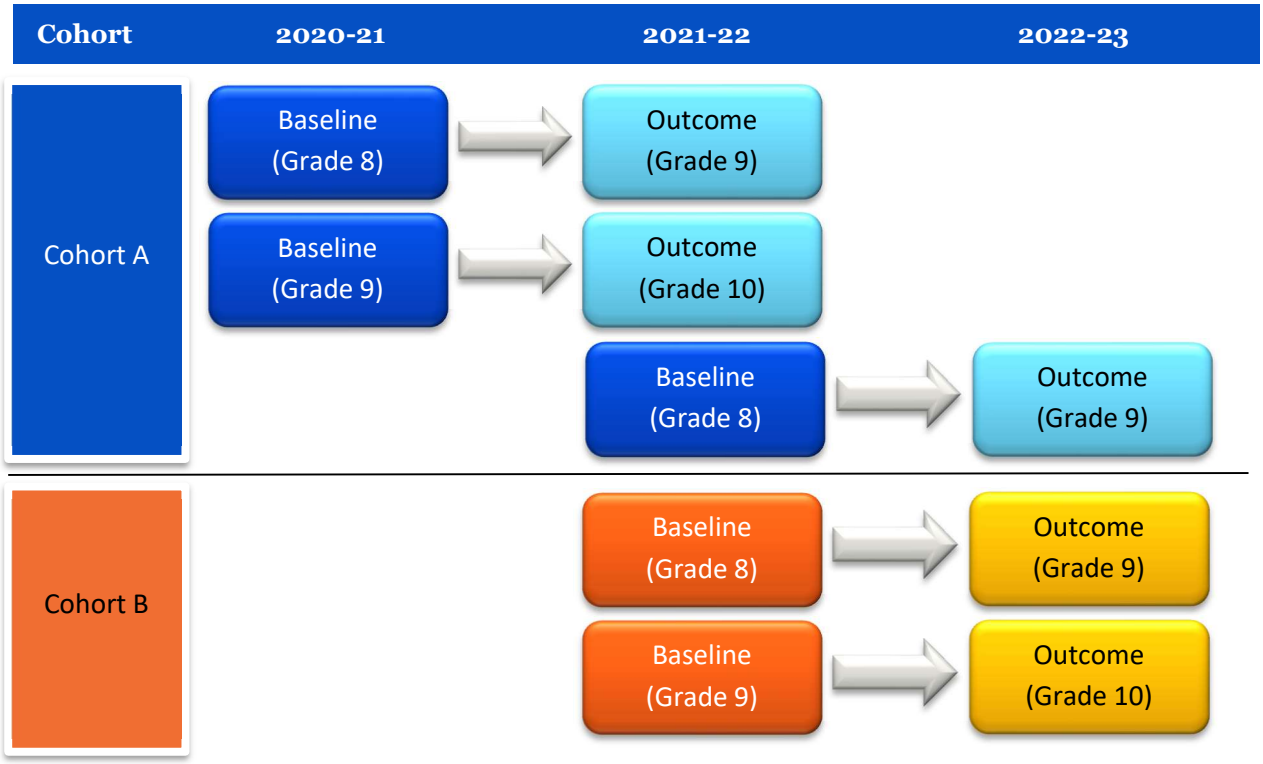
Broadly speaking, the treatment group in this analysis consists of students in Cohort A and B schools and the comparison group consists of North Carolina students who were *not* in one of the treatment schools. However, the sample is different from that broad group in four ways.

First, we included only students in grade 9 or 10 in mainstream ELA, social studies, and/or science courses (i.e., not special education or English learner pull-out courses). These were the courses taught by RA-trained teachers in the treatment schools.

Second, we include only students who had valid baseline and outcome data. That means that these students had course grades in the year that they were exposed to RA and either test scores or a grade point average (GPA) in the prior year. We did not fill in missing data. See Appendix A for the number of students excluded by these criteria.

Third, in the treatment group we focus on students who had only been exposed to RA-trained teachers for one year (not the full two years of the intervention). This included 9th- and 10th-grade students in Cohort A schools in the 2021-22 school year (their first year of implementation) and 9th- and 10th-grade students in Cohort B schools in the 2022-23 school year. It also included 9th-grade students in Cohort A schools in the 2022-23 school year (the schools' second year of implementation). These students were new to the treatment high schools in the second year of implementation, so they had not been exposed to RA-trained teachers in the previous year, when they were in middle schools. Exhibit 1 shows the groups of treatment students, by cohort and grade level, who were included in the analyses.

Exhibit 1. Treatment student sample



Finally, in the comparison group we used a matching approach to identify students who similar to treatment students on key demographic and achievement variables. This is explained further in the "Matching strategy" section below.

Matching Strategy

To measure the impact of RA in North Carolina on students, we needed to identify a group of students who *were not* exposed to RA to use as a comparison group. It is crucial, however, to identify students who were as similar as possible to the treated students so that any differences in course grades can be attributed to the intervention and not to pre-existing differences between the students. We accomplished this using a two-stage matching approach. In the first stage, we used a statistical model to assign scores to each potential comparison student that represented their similarity to treatment students, based on the demographic variables outlined in the "Data and Measures" section above. These scores, called "propensity scores" were higher for students who were more like treatment students and lower for students who were more different from treatment students.

Next, we identified the non-treatment schools in North Carolina that had the highest propensity scores among their students. These schools had students that were most like the treatment group, and they were selected to serve as our comparison group. SRI was able to identify three comparison schools for every treatment school in Cohorts A and B.

The matching approach yielded a comparison group of students that was comparable to our treatment students in baseline achievement levels, the proportion of students who were designated as low-income, and the proportion of White, non-Hispanic students. To meet the What Works Clearinghouse (WWC) requirement for baseline equivalence, the differences on these variables must be less than 0.25 standard deviation (WWC, 2022). As shown in Exhibit 2, all baseline differences were within those bounds. These variables, along with the others outlined in the Methods section, were also included in the models, to further account for any lingering pre-existing differences between students and to increase the precision of the estimates.

Exhibit 2. Baseline differences between treatment and control students

Grade level	Course	Baseline achievement	Designated low-income	White, non-Hispanic
Grade 9	ELA	0.034	-0.001	0.20
	Science	-0.134	0.040	0.12
	Social studies	-0.015	-0.013	0.06
Grade 10	ELA	-0.045	0.038	0.18
	Science	0.037	0.013	0.16
	Social studies	-0.105	0.023	0.01

Note. Differences are shown in standard deviation units (Cohen's *d* for the continuous achievement variable and Cox's index for the binary low-income indicator)

Analysis Approach

Once we identified the matched comparison schools, we analyzed the impact of RA on students' course grades, accounting for two important characteristics in the data. First, course grades are not a continuous variable. Instead, they fall into one of five discrete categories, and those categories have a built-in order, where A is highest and F is lowest. Thus, the outcome is an ordinal variable. Second, course grades tend to be more similar within the same courses, teachers, and schools. This "nesting" affects the calculation of the estimates in the models, so we account for it using a multi-level modeling approach (Raudenbush & Bryk, 2002).[1] For more detail on the models used in the analysis, see Appendix A.

[1] Specifically, we used multi-level ordinal logistic regression to estimate impacts with students nested within classrooms, nested within schools.

Results

As shown in

Exhibit 3, RA had a statistically significant, positive impact on students' course grades in ELA and science in both grades 9 and 10. There was no significant impact on students' course grades in social studies.

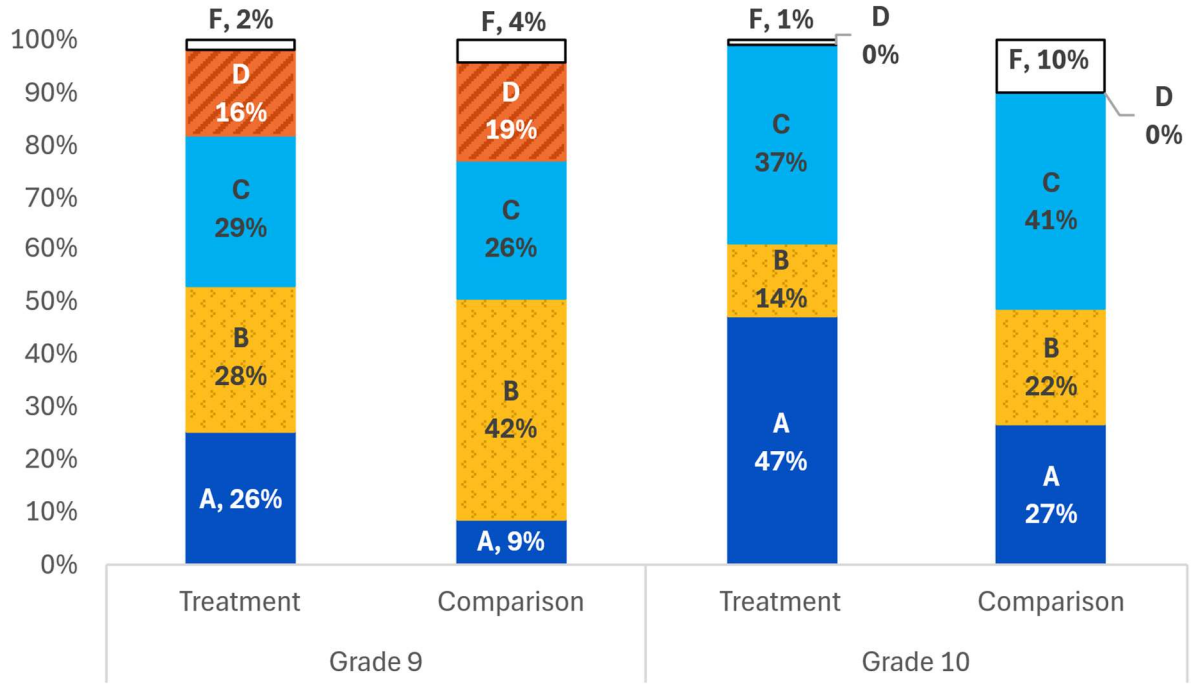
Exhibit 3. Impact of RA on student course grades

Grade level	Subject	Coefficient	Standard error	Number of students
Grade 9	ELA	0.89***	0.205	5,894
	Science	2.01***	0.477	4,190
	Social studies	-0.26	0.372	11,761
Grade 10	ELA	0.63*	0.295	3,551
	Science	0.89**	0.260	3,662
	Social Studies	0.31	0.277	6,656

*** $p < 0.001$ ** $p < 0.01$ * $p < 0.05$

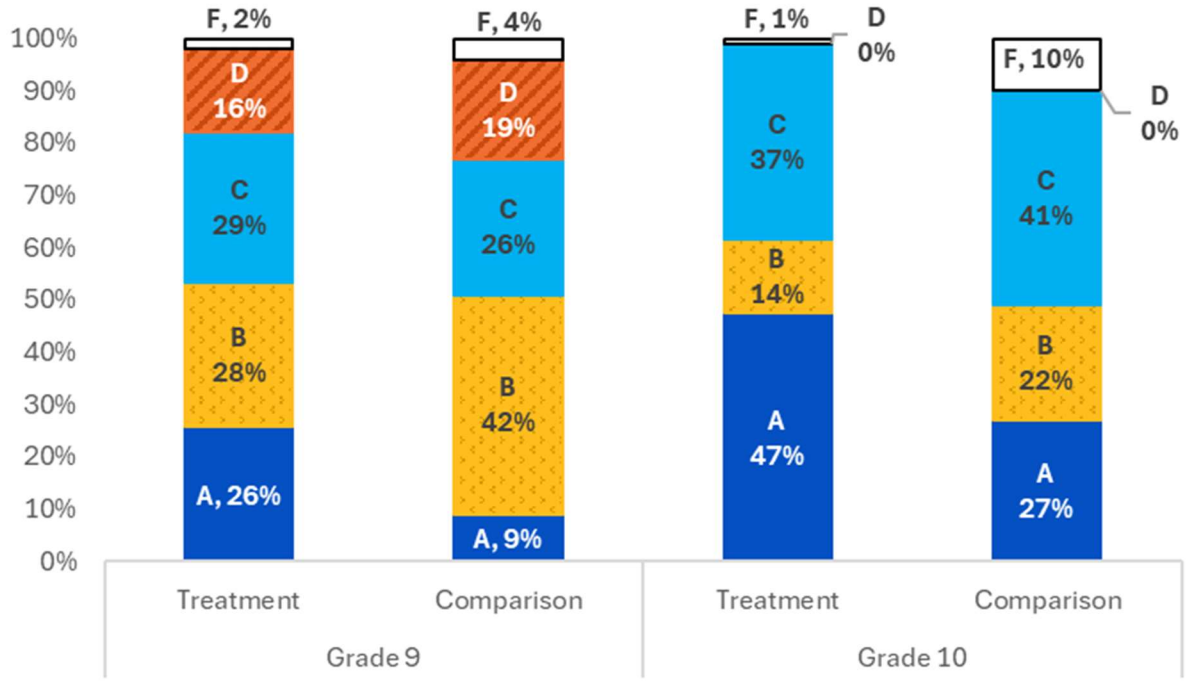
Using the results of these models, we can predict the grade students would get in each course after adjusting for demographic differences. Exhibit 4 shows these predicted course grades in ELA. The difference in ELA course grades was most evident in the proportion of students who were predicted to get As in their courses (Exhibit 4). After accounting for student, course, teacher, and school demographics, the proportion of treatment students who were predicted to get an A in their 9th grade ELA course was 26 percent, compared with 9 percent of comparison students. Similarly, in grade 10, 48 percent of treatment students were predicted to get As, compared with 27 percent of comparison students.

Exhibit 4. Distribution of predicted ELA course grades among treatment and comparison students



The same pattern was evident in science course grades, where the impact was especially strong in grade 9. More than 90 percent of treatment students were predicted to get an A in science in grade 9, compared with just over half of the comparison students. In grade 10, 36 percent of treatment students were predicted to get an A in science, compared with 22 percent of comparison students.

Exhibit 5. Distribution of predicted science course grades among treatment and comparison students



Conclusion

The early results from this quasi-experimental study of the impact of Reading Apprenticeship in North Carolina show a statistically significant, positive impact of one year of the intervention on students' course grades in ELA and science in both grades 9 and 10. This impact was most evident the percentage of treatment students predicted to get an A in their core ELA and science courses, which was significantly larger than for similar students whose schools did not participate in RA. Future research will examine the impact of two full years of RA professional learning on student outcomes as well as the how RA was implemented across cohorts during the study.

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Appendix A. Methods

Data and Measures

SRI used North Carolina administrative data from NCERDC to carry out a variation on the optimal matching approach (Zubizarreta & Keele, 2017), where students were matched first and then the schools with the best matches were selected to serve as the comparison group. This approach results in balanced covariates at both the school and student level (Zubizarreta & Keele, 2017).

For each outcome sample, we first used logistic regression to fit propensity scores at the student level using the variables shown in Exhibit A-1. We then ranked all non-treatment schools in North Carolina by both the average propensity score and the total propensity score across all of their students. Finally, we selected the comparison schools with the lowest rank (highest total and average propensity score) at a rate of three comparison schools for every one treatment school.

Exhibit A-1. Variables used for matching

	Variable	Source	Definition
Student variables	Baseline achievement	Tests and Transcripts files	For grade 9 outcomes, the grade 8 reading end-of-grade test score (SCORE) For grade 10 outcomes, the grade 9 GPA in ELA, social studies, and science (FINAL_MARK)
	Race/ethnicity	Masterbuild file	Binary variables created from race/ethnicity (ETHNIC): African American or Black non-Hispanic (B) Asian non-Hispanic (A) Hispanic, any race (H) Other race non-Hispanic (I, M, P) White non-Hispanic (W) serves as the comparison group
	Gender	Masterbuild file	Male (SEX = M) vs. non-male (SEX = F)
	Special education status	Masterbuild file	Identified as a student with disabilities (SWD = Y)
	English learner status	Masterbuild file	Student is identified as an English learner (ELS = Y, 1, or 2)
	Socioeconomic status	Masterbuild file	Flagged as “economically disadvantaged” (EDS = Y)

Exhibit A-1. Variables used for matching, concluded

	Variable	Source	Definition
Teacher variables	Highest degree earned	Licensure file	Highest value from CLS_LVL_CD variable, where Doctoral degrees > Masters degrees > Bachelors degrees >
	Years of teaching experience	Licensure file	Continuous variable based on EXPER_NUM, with values >52 years suppressed
	Certification	Licensure file	Two binary variables based on LIC_AREA_CD, indicating if teachers have a certification: in the grade level of the outcome (grade 9 or 10) in the subject area of the outcome (social studies, science, or ELA
Classroom variables	Course type	Transcript file	Binary variables created from ACADEMIC_LEVEL_DESC: Honors (value of 2 in the original variable) Co-op (6) Advanced Placement (7) International Baccalaureate (8) Comparison group is Standard (2) Modified Curriculum (0), Abridged/Adapted/Remedial (1), and Non-Classroom Activity (9) were excluded from analysis
	Course format	Transcript file	Binary variable for "regular" versus virtual and other class formats (HOW_TAKEN_DESC = REGULAR DAY SCHOOL or missing)
School variables	Percent white	Calculated	Calculated percentage of students identified as "White" race/ethnicity in the data provided
	Percent male	Calculated	Calculated percentage of students identified as "male" gender in the data provided
	Percent receiving special education services	Calculated	Calculated percentage of students identified as SWD=Y in the data provided
	Percent English learners	Calculated	Calculated percentage of students identified as ELS = Y, 1 or 2 in the data provided
	Percent flagged as low-income	Calculated	Calculated percentage of students identified as EDS = Y in the data provided

Constructing a common course grade scale

Course grades are submitted to the state and housed by NCERDC in a variety of forms. To use these grades across districts and schools, SRI needed to construct a common scale. The final course grade variable used in this analysis was on a five-point scale, from 0 (F or fail) to 4 (A). Exhibit A- 2 shows a crosswalk between the original values found in the FINAL_MARK variable

and the value used for the constructed course grade variable. We excluded course outcomes that: a) only indicated passing the course (P, PASS, S, S+), b) indicated incomplete, audited, withdrawals, and non-credit courses (I, INC, AUD, N/C, NC, W, WC19, WD, WF, WP), and c) course grade values that were not explained in the codebook and we could not easily map to a five-point grade scale (AW, CDM, DR, E, EX, FA, FF, IP, NA, NEX, R).

Exhibit A- 2. Crosswalk of course grade original values with constructed variable values

New scale value	Grade as recorded
4	A+
	A
	A-
	>=90
3	B+
	B
	B-
	>=80 & <90
2	C+
	C
	C-
	>=70 & <80
1	D+
	D
	D-
	N (needs improvement)
	>=60 & <70
0	F
	<60
	Fail
	U

Sample

The sample for this analysis was restricted to students in grade 9 or 10, who took mainstream ELA, social studies, or science courses, and who had both baseline and outcome data. Comparison students were restricted to those who were in matched comparison schools. Exhibit A- 3 and Exhibit A-4 show the number of students excluded from the sample as a result of each criterion.

Exhibit A- 3. Comparison students excluded from each analysis sample

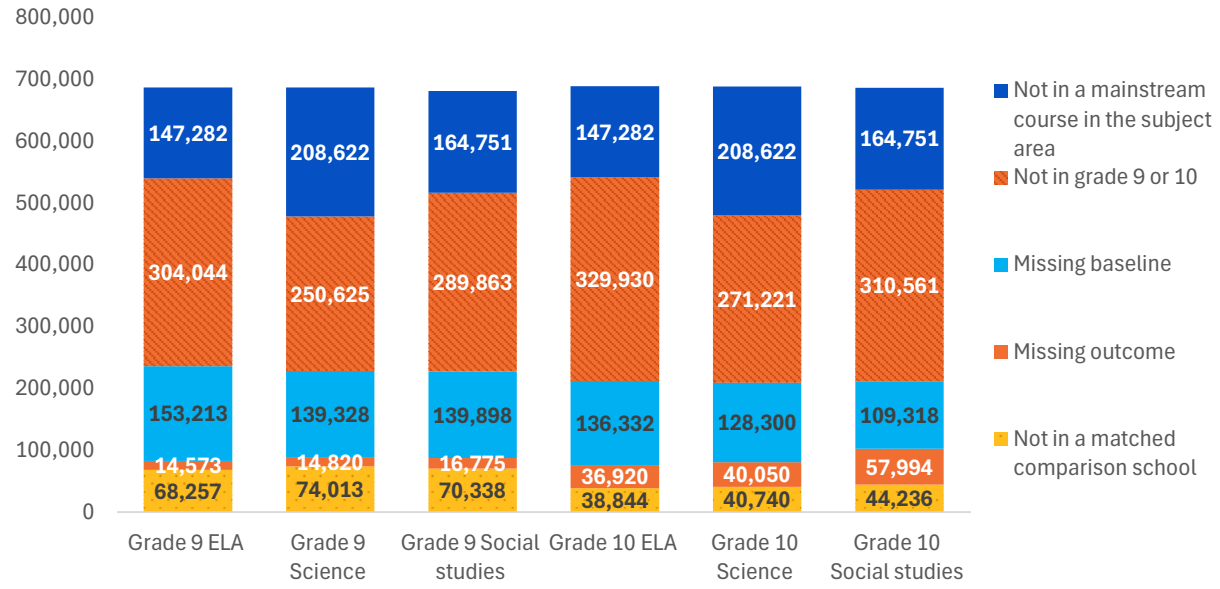
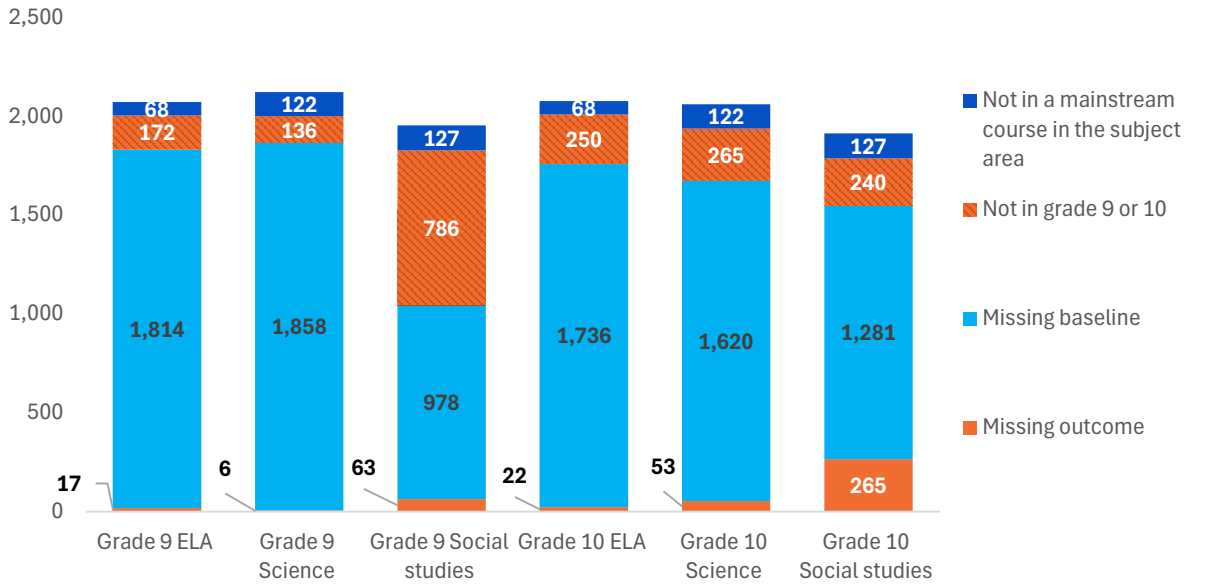


Exhibit A- 4. Treatment students excluded from each analysis sample



The students who were excluded from the analysis because they were not in the target grade or subject is not surprising, since the dataset included all students in all North Carolina schools. By focusing on specific grades and subjects as outcomes, these students are necessarily excluded from the population of interest. Likewise, the matched comparison group design automatically excludes a portion of students in the data who are substantially dissimilar from treatment students.

However, a large group of students who were in the target grades and subjects, and in either treatment or matched comparison schools, were missing baseline course information and/or test scores and so were excluded from the analysis. This represents a substantial missing data problem that may limit interpretation of the findings.

The final sample sizes for each analysis are shown in Exhibit A-5. Although the ratio of comparison to treatment schools was 3:1, the ratio of students is larger. This is partly due to the fact that students in comparison schools were less likely to be missing baseline data, and partly due to comparison schools being slightly larger, on average, than treatment schools.

Exhibit A- 5. Final student sample sizes for analysis

Grade level	Course	Comparison students	Treatment students	Total students
Grade 9	ELA	4,642	89	4,731
	Science	4,603	38	4,641
	Social studies	10,386	206	10,592
Grade 10	ELA	2,703	84	2,787
	Science	3,078	100	3,178
	Social studies	5,151	247	5,398

Analysis approach

The models used to estimate the impact of RA on student courses grades were three-level ordinal logistic regression models, with students nested within teachers, nested within schools.[2] The models took the following form:

$$y^*_{ijk} = \gamma_{000} + \gamma_{100}Treatment_k + \gamma_{200}School_k + \gamma_{010}Teacher_{jk} + \gamma_{001}Student_{ijk} + e_k + u_{jk} + \alpha_{ijk}$$

In this model, y^*_{ijk} represents the unobserved latent variable of student continuous course grades, and it is regressed on a binary treatment indicator at the school level ($Treatment_k$), vectors of school-, teacher-, and student-level covariates ($School_k$, $Teacher_{jk}$, and $Student_{ijk}$, respectively). School-, student, and teacher error terms are represented as e_k, u_{jk} and α_{ijk}.

For all six outcomes (three course subjects and two grade levels in each subject), we started with the basic model above. However, given the small treatment sample sizes, in some cases we had to drop individual covariates to reach convergence. The final set of covariates included in the models are shown in Exhibit A-6. Additionally, the model for grade 10 science course grades would not converge with the teacher level included because there was not enough variation between teachers within schools. Therefore, that model included only two levels: students nested within schools.

[2] We also explored four-level models, using course as a nesting variable. However, those models would not converge.

Exhibit A- 6. Final covariates included in each model

Covariate	Grade 9			Grade 10		
	ELA	Science	Social studies	ELA	Science	Social studies
Baseline achievement	✓	✓	✓	✓		✓
Cohort indicator	✓	✓	✓	✓	✓	✓
School year indicator	✓	✓	✓	✓	✓	✓
Student-level variables						
Low-income	✓	✓	✓	✓	✓	✓
Black or African American	✓	✓	✓	✓	✓	✓
Hispanic	✓	✓	✓	✓	✓	✓
Asian	✓	✓	✓	✓	✓	✓
Other race	✓	✓	✓	✓	✓	✓
Male	✓	✓	✓	✓	✓	✓
Receives special education	✓	✓	✓	✓	✓	✓
English learner	✓	✓	✓	✓	✓	✓
Teacher/course-level variables						
Years of experience	✓	✓	✓	✓	✓	✓
Highest degree		✓	✓	✓		✓
Certified in subject area of outcome		✓	✓	✓		✓
Certified in grade level of outcome		✓	✓	✓		✓
Honors course		✓	✓	✓		✓
Co-op course		✓	✓	✓		✓
Advanced placement course		✓	✓	✓		✓
International Baccalaureate course		✓	✓	✓		✓
“Regular” format course		✓	✓	✓		✓
Semester 2 only		✓	✓	✓		✓
Semester 3 only		✓	✓	✓		✓

Exhibit A-6. Final covariates included in each model, concluded

Covariate	Grade 9			Grade 10		
School-level variables						
Percent white, non-Hispanic	✓	✓	✓	✓	✓	✓
Percent low-income	✓	✓	✓	✓	✓	✓
Percent male	✓	✓	✓	✓	✓	✓
Percent receive special education	✓	✓	✓	✓	✓	✓
Percent English learners	✓	✓	✓	✓	✓	✓

Additional information for WWC review

The analyses reported here fall into the Course Performance outcome domain. As described above, the course grades were transformed to be on the same scale across schools and districts. Grade Point Average (GPA) was used as a baseline measure for the outcomes of student course grades in grade 10 because North Carolina students do not take any state standardized tests in grade 9. The GPA used as a baseline measure was calculated by the study, using the average of the students' course grades in ELA, science, and social studies in grade 9 (transformed in the same manner as the outcome variable).

The unit of assignment in this study was schools: all grade 9 and 10 mainstream social studies, science, and ELA teachers in treatment schools were invited to participate in the RA professional learning and coaching. We used an intent-to-treat approach, including all students who were in these courses in treatment schools in the analysis, regardless of whether their teachers attended the training. Likewise, our matching approach identified comparison schools who had the most similar students to treatment schools, and then all students in grade 9 or 10 mainstream social studies, science, or ELA courses were included in the comparison group. Students who moved between treatment and comparison schools within the school year were excluded from the analysis, to create distinct (non-overlapping) groups.

Baseline equivalence was established for all six samples in this study, as shown in Exhibit A- 7. The standardized differences in the baseline measures for achievement, the probability of a student being low-income (a measure of socioeconomic status), and the probability of a student's race being white, non-Hispanic (a measure of race/ethnicity) were all less than 0.25 standard deviation. These measures were also included in all models as covariates, to account for lingering differences between the groups and increase precision. The one exception was the grade 10 science outcome, where the baseline achievement difference was less than 0.04 standard deviation, and the model would not converge with that variable included. Therefore, that model only controlled for the other demographic variables, as shown in Exhibit A-6.

Exhibit A- 7. Baseline achievement and demographics by analytic sample and treatment status

		Grade 9			Grade 10		
Measure	**Group**	**ELA**	**Science**	**Social studies**	**ELA**	**Science**	**Social studies**
Baseline achievement (standardized tests in grade 9 and GPA in grade 10)	Treatment	542.4	531.4	502.8	3.08	2.58	3.38
	Comparison	545.0	513.7	500.4	2.55	2.71	2.07
	Difference	2.6	17.7	2.4	5.4	0.13	1.31
	Standardized difference	**0.03**	**0.13**	**0.02**	**0.05**	**0.04**	**0.11**
Low-income	Treatment	0.509	0.316	0.530	0.515	0.49	0.482
	Comparison	0.510	0.336	0.523	0.534	0.497	0.494
	Difference	0.001	0.02	0.01	0.02	0.01	0.01
	Standardized difference	**0.001**	**0.04**	**0.01**	**0.04**	**0.01**	**0.02**
White non-Hispanic	Treatment	0.296	0.439	0.265	0.206	0.308	0.473
	Comparison	0.369	0.498	0.293	0.278	0.379	0.267
	Difference	0.07	0.06	0.03	0.07	0.07	0.01
	Standardized difference	**0.198**	**0.12**	**0.06**	**0.18**	**0.16**	**0.01**
Number of students		**4,731**	**4,641**	**10,592**	**2,787**	**3,178**	**5,398**

SRI Education, a division of SRI, is helping federal and state agencies, school districts, major foundations, nonprofit organizations, and international and commercial clients tackle some of the most complex issues in education to help students succeed. Our mission is **to reduce barriers and optimize outcomes for all children, youth, and families.** We do this by conducting high-quality research, supporting use of data and evidence, helping to strengthen state and local systems, and developing tools that improve teaching and accelerate and deepen learning. Our work covers a range of topics, including early learning and development, student behavior and well-being, teaching quality, digital learning, STEM and computer science, literacy and language arts, and college and career pathways.

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