NYU STEINHARDT

AMNH RGGS MAT Earth Science Residency Program

Year 9 Impact Report

Meryle Weinstein, PhD
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Executive Summary

The American Museum of Natural History's RGGS Earth Science Residency Program (hereafter, AMNH RGGS) continues to address the critical shortage of Earth Science teachers in grades 7-12 in high-need schools in New York State; between 2014 and 2022, the program has prepared almost 50% of new Earth Science teachers in New York City and almost 18% statewide.[1] Researchers from NYU's Steinhardt School of Culture, Education, and Human Development have been working with the program since its inception to provide quantitative analyses on important program outcomes. In this report we address two research questions: 1) What are the demographic and educational characteristics of students taught by AMNH RGGS graduates in New York City; and 2) Do New York City public school students taught by AMNH RGGS graduates do better on the New York State (NYS) Earth Science Regents exam compared to similar students not taught by AMNH RGGS graduates

The year 9 report continues our analysis of who AMNH RGGS graduates teach and their impact on student achievement in Earth Science. This report is based on nine cohorts of AMNH RGGS graduates who have taught at least one year in New York City schools. We compare the students of these teachers to a sample of students matched using observable student, teacher, and school characteristics. This year's report also provides the first analysis on RGGS graduates since the COVID-19 pandemic and includes the first data we have on graduates from cohorts seven through nine.

[1] Author's calculation from NYS Department of Education data.

The analysis that follows differs from previous years in that we start with all students in grades 9 through 12 enrolled in an Earth Science course in each year, rather than all students who have taken the Earth Science Regents in each year; this means that our sample is limited to students who take the course and Regents in the same year. Additionally, we provide separate descriptive analysis for students in grades 6 to 8 and 9 to 12.

We use the NYS Earth Science Regents results from 2014 to 2019 and 2022, including z-scores, and passing at 65 and 85 or higher as our outcome of student achievement. In NYS, high school students are required to take five Regents exams to graduate. These end-of-course exams are typically taken in June of the school year in which the course is taken. The Earth Science Regents is one of four science Regents that students can take (alongside Living Environment, Chemistry, and Physics) that fulfill graduation requirements. Unlike high school exit exams used in other states, the Regents are not taken in a particular grade but are taken at the end of the course. In some schools this means that students take the Earth Science Regents in 9th grade, while in other schools they could be taken in grade 10 or 11.

Our Year 9 analysis finds that:

- **AMNH RGGS teachers continue to teach students who are disadvantaged**. Over the nine years of our study, students taught by RGGS graduates are more likely to be poor, Black, and Latino compared to students citywide. In 2021-22, almost 80% of students in grades 6-12 were eligible for free and reduced-price lunch and 75% were Black and Latino.
- **AMNH RGGS graduates also continue to teach students with high educational needs**. RGGS graduates continue to teach high percentages of students with disabilities, English

learners, and poorly performing students. In 2021-22 21.2% were students with disabilities, 14% were English language learners, and over 40% spoke a language other than English at home. There are some differences with the middle school sample, where there is a higher percentage of students with disabilities, and lower percentages of students who are English language learners or who have a home language other than English. While RGGS students had, on average, higher 8th grade scores on the NYS Intermediate Level Science exam than non-RGGS students, the majority of RGGS students still score below the citywide average.

- **Students of AMNH RGGS graduates are more likely to take the Earth Science Regents compared to other students enrolled in Earth Science courses in most years.** In 2015-2019, students enrolled in Earth Science taught by an AMNH RGGS graduate were slightly more likely to take the Earth Science Regents compared to students with non-RGGS teachers. However, in 2022, only 48.1% of RGGS students took the exam, compared to 50.3% of students with non-RGGS teachers.
- **Students of AMNH RGGS graduates continue to outperform students of non-RGGS teachers.** In 2018-19, the last year in which the Regents exams were given before the pandemic, RGGS students score 0.12 standard deviations ($p < 0.001$) higher than non-RGGS students and are 4.4 percentage points ($p < 0.05$) and 3.9 percentage points ($p < 0.01$) more likely to pass at 65 and 85 and higher. While RGGS students in 2022 still outperformed other students, the results are lower compared to previous years; in 2022, students of RGGS graduates score 0.05 standard deviations higher on the NYS Earth Science Regents, were 2.4 percentage points more likely to pass the Regents at 65

or higher and 5.0 percentage points more likely to pass at 85 or higher, although these differences are not statistically significant. In more practical terms, the 2021-22 results indicate that students move from a score of 57.4 to 58.4; 55 additional students pass at 65 or higher and 116 additional students pass at 85 or higher.

- **Results are not sensitive to different sample specifications.** Robustness checks were conducted using two alternative sample specifications and results were consistent with those of the main sample.

The Covid-19 pandemic has presented limitations to our continued analysis of the AMNH RGGS program. First, NYS Regents exams were not given in the 2019-20 and 2020-21 schools years and students did not need to make up exams for graduation. Therefore, we have limited data on students taught by teachers in cohorts 7 and 8 and only begin to see the how their students are doing in their 2nd and 3rd year of teaching. To account for this, we conduct a separate analysis limited to RGGS graduates in cohorts 1-6. Results from this are similar to our full sample, although the coefficients for 2016 are more than twice as high as those in the full sample (0.36 standard deviations vs 0.15 standard deviations). Secondly, the Intermediate Level Science (ILS) exam, which we use as a measure of past performance, was also suspended in 2019-20. Therefore, the results from 2021-22 are based on a small number of students (fewer than 700) who had taken Earth Science Regents and had 8th grade ILS scores. In order to account for this limitation, we conducted a separate analysis of 2021-22 results without controlling for past performance (n=6,833). The results showed that RGGS students score 0.07sd higher than other students. However, it is likely that there are unobserved differences between RGGS and non-RGGS students that are not controlled for in this analysis.

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I. Introduction

The American Museum of Natural History's RGGS Earth Science Residency Program (hereafter, AMNH RGGS) continues to address the critical shortage of Earth Science teachers in grades 7-12 in high-need schools with diverse populations in New York State (NYS); between 2014 and 2022, the program has prepared almost 50% of new Earth Science teachers in New York City (NYC) schools and almost 18% statewide.[2] Researchers from NYU's Steinhardt School of Culture, Education, and Human Development have worked with program staff since 2013 to provide quantitative analyses on important program outcomes. We address two questions in this report: 1) What are the demographic and educational characteristics of students taught by AMNH RGGS graduates? and 2) Do students of AMNH RGGS teachers do better on the NYS Earth Science Regents exam than similar students not taught by AMNH RGGS graduates?

The year 9 report provides the first results of how well students in New York City public schools performed on the NYS Earth Science Regents since the Covid-19 pandemic, including the first results of students of graduates in cohorts 7-9. There are also some changes in our methodology; we limit our analysis to students who were enrolled in Earth Science classes in NYC public schools and took the Regents exam in the same year. Our outcome of interest continues to be the NYS Earth Science Regents exam. In NYS, high school students are required to take five Regents exams to graduate. These end-of-course exams are typically taken in June of the year they've taken the course. The Earth Science Regents is one of four science Regents that students can take (alongside Living Environment, Chemistry, and Physics) to fulfill the

[2] Author's calculation from NYS Department of Education data.

graduation requirements. Unlike high school exit exams in other states, the Regents are not tied to a particular grade; in some schools, students will take Earth Science in grade 9, while in others they may take it in 10^{th} or 11^{th} grade.

Findings from the Year 9 analysis show that AMNH RGGS teachers continue to teach students who are disadvantaged. In 2021-22, almost 80% of students of AMNH RGGS teachers in grades 6-12 were eligible for free and reduced-price lunch, 21.2% were students with disabilities, and almost 75% were Black and Laitno. Unfortunately, we have limited data on previous science performance of these students, since students in 8^{th} grade in the 2019-20 school year did not take the Intermediate Level Science (ILS) test due to the COVID-19 pandemic, when all or most standardized testing was cancelled.

This report is organized as follows: Section II describes our data and Section III presents the methodology. The findings are in Section IV and the conclusions are in Section V. The appendices are in Section VI.

II. Data

As in prior years, we use detailed student- and teacher-level data provided by the New York City Department of Education (NYCDOE) to conduct these analyses. These data include student-teacher linkage and course files for grades 6-12 for school years 2013-14 through 2021-22, student-level demographic and educational files, NYS Regents exam results, and data on all teachers working in NYCDOE schools. AMNH RGGS staff provided a list of schools by cohort and year where AMNH RGGS graduates are teaching. Each AMNH RGGS graduate is matched to a scrambled teacher ID based on assigned school, licensure field, teaching assignment field, number of years teaching at the NYCDOE, and appointment date that are in the personnel file. Students are matched to teachers using the student-linkage files.

The student level files include socio-demographic characteristics (gender and race/ethnicity, and eligibility for free/reduced-price lunch), educational needs (special education and English language learner (ELL) status), and school, grade, and standardized test scores (statewide English language arts and math exams in Grades 3-8, science exams in Grades 4 and 8. All of the data have unique person and school identifiers that allow us to track individual students and teachers across schools and over time.[3]

In our matching process we also used school-level data from the *New York State School Report Cards (SRC)*, which contain data on enrollment and demographic characteristics of students at each school.

[3] All student and teacher files are de-identified and are matched using a scrambled identification number.

For grades 9-12, NYC public school students enrolled in Earth Science in each year were identified and matched to their Earth Science teacher using the student-teacher linkage file. Next, the list of RGGS graduates who were teaching in each year was matched to this file to identify RGGS and non-RGGS teachers. While Section IV presents descriptive analyses for students in grades 9-12 and students in grades 6-8 (separately), the analytic sample for the regression analysis includes only students in grades 9-12 in the 2013-14 through 2019-20 and 2021-22 school years (Cohorts 1-9), excluding the 2020 and 2021 school years. Students in grades 3-8 were matched to their science teacher, then to the RGGS data, since science classes are not identified by subject at the middle school level.

Table II-1 describes AMNH RGGS schools (i.e. schools where at least one AMNH RGGS graduate is teaching) compared to all other NYC public middle and high schools (excluding special education only schools). During 2021-22, AMNH RGGS teachers were teaching in schools that had higher percentages of students who are poor, Latino, Asian, White, and English Language Leaners (ELLs) compared to the citywide average. AMNH RGGS schools also had lower percentages of students who were Black, or students with disabilities (SWDs) compared to the citywide average. The set of AMNH RGGS schools in 2021-22 is similar to the 2020-21 school year, though there is a lower percentage of Black students and a higher percentage of Asian, White, and ELL students.

Table II-1. Demographic and Educational Characteristics of AMNH RGGS Schools Compared to Other Similar NYC Schools 2020 and 2021

	2020-21		2021-22	
	RGGS	NYC*	RGGS	NYC*
% Poor	82.3	80.6	79.0	78.7
% Black	28.6	34.6	25.9	34.3
% Latino	53.0	44.2	51.5	44.9
% Asian	7.8	9.6	10.0	9.3
% White	7.9	8.8	9.9	8.5
% Multi/Other	2.4	2.7	1.0	2.3
% Female	49.5	48.6	49.3	48.2
% Students with disabilities	22.7	22.3	21.2	23.4
% English language learners	13.1	12.5	15.7	13.6
N Schools	65	879	62	912
N AMNH RGGS Teachers	77		79	

Source: NYC Open Data

*Analysis is limited to NYC schools, including charter schools, with any students in grades 6-12. District 75 schools are excluded.

III. Methodology

Our analysis focuses on students of AMNH RGGS teachers matched to a comparison group of students based on student, teacher, and school characteristics. The methodology is similar to previous years' analyses although we now identify the sample based on enrollment in Earth Science courses in each year, rather than simply taking the Earth Science Regents. Then we link them to their Earth Science teacher, along with the teacher characteristics, including RGGS status. These files were then linked to Earth Science Regents test scores and biographic files, which contain socio-demographic and educational data, and performance on the 8th grade ILS exam, when available and finally, to the *SRC* school-level data.

Our matching process relied on nearest neighbor (NN) and entropy balancing to create a comparison group with the same observable characteristics as the treatment group. These techniques enable us to use observational data to replicate a randomized experiment to obtain "balance on covariates" between treatment and comparison groups (Stuart, 2010; Hainmueller, 2012). Nearest neighbor matching with replacement matches control individuals to the treated group and discards controls not selected. This method is useful for when there are a small number of covariates and they are normally distributed, as is our data. Using *with replacement* allows comparison group members to be used more than once and helps to ensure the quality of the match doesn't depend on the order of the observations. We use five as the number of matches because multiple controls decreases the variance between observations. Along with nearest neighbor matching, entropy balance further reweights the observations to balance the covariates and drops observations farthest away in the covariate distribution. We use the Stata procedure *kmatch* to do the matching (Jain, 2017). We use an exact match of RGGS students on year, eligibility for free and reduced lunch, race/ethnicity, gender, English language learner and disability status, and grade. We then do a nearest neighbor match on prior performance on the 8th grade ILS exam using z-scores, teacher characteristics using license subject, assignment subject, and years at the NYCDOE, and school characteristics including borough where school is located, total enrollment, and percent of students who are Black, Latino, Asian, White, and multiracial, and percent who are economically disadvantaged.

We identified over 548,794 students who were enrolled in Earth Science between 2014-15 and 2022, 5.8% are taught by RGGS graduates (Table III-1). Only students who were enrolled in an Earth Science course and took the Earth Science Regents in that year were used to match the treatment and comparison group (n=209,436); our final analytic sample is 21,566 students.

Table III-1. Percentage of Students by RGGS by Year, Grades 9-12, 2014-15 to 2021-2-

	Took Earth Science Regents	In Matched Sample

	Enrolled in Earth Science Course								
	RGGS (%)	Not RGGS (%)	Total	RGGS (%)	Not RGGS (%)	Total	RGGS (%)	Not RGGS (%)	Total
2014	1,451	60,526		552	27,702		419	1120	
	(2.3)	(97.7)	61,977	(2.0)	(98.0)	28,254	(27.2)	(72.8)	1,539
2015	2,281	59,361		1,079	28,183		816	1896	
	(3.7)	(96.3)	61,642	(3.7)	(96.3)	29,262	(30.0)	(70.0)	2712
2016	3,252	58,220		1,577	29,515		1135	2567	
	(5.3)	(94.7)	61,472	(5.0)	(95.0)	31,092	(36.9)	(63.1)	3702
2017	4,146	58,118		1,850	30,726		1261	2606	
	(6.7)	(93.3)	62,264	(5.7)	(94.3)	32,526	(32.6)	(67.4)	3867
2018	4,519	59,751		2,152	30,056		1321	2787	
	(7.0)	93.0)	64,270	(6.7)	(93.3)	32,208	(32.2)	(67.8)	4108
2019	4,879	56,398		2,149	28,135		1613	3356	
	(8.0)	92.0)	61,277	(7.0)	(93.0)	30,284	(32.5)	(67.5)	4969
2020	4,083	57,229		NA	NA				
	(6.7)	(93.3)	61,312						
2021	6,071	52,494		NA	NA				
	(10.4)	(89.6)	58,565						
2022	6,141	45,305		2,327	23,433	25,760	221	448	669
	(11.9)	(88.1)	51,446	(9.0)	(90.1)		(33.0)	(67.0)	
Total	31,586	517,208		11,686	197,750	209,436	6786	14,780	21,566
	(5.8)	(94.2)	548,794	(5.6)	(94.4)		(31.5)	(69.5)	

NA – Earth Science Regents were not given due to the COVID-19 pandemic.

Further analysis shows that the treatment and comparison groups are balanced at baseline in each year of the analysis (see Appendix Figure A1). The graphs show the results only for those variables that have not been set to an exact match. If we have a good match, we will see a standard mean difference of 0 and a variance ratio close to one. The variance ratio is computed by dividing the variance of group one by the variance of group two. If this ratio is close to one the conclusion is that the variance of each group is the same. The blue dots are the results for the raw data while the red dots are those for matched sample.

The charts show the results of the matches for past performance on the Intermediate Level Science exam in 8th grade, as measured by the z-score; teacher characteristics including number of years at DOE, assignment and license; and school characteristics of borough, total enrollment and percent of economically disadvantaged, Black, Hispanic, Asian, and White students. In other words, students of RGGS graduates are matched to students with similar characteristics and who have teachers who are similar to RGGS graduates in years of teaching experience and licensure. The only characteristic in each year that was not matched well is for schools in Staten Island, which is unsurprising given Staten Island has the fewest schools and students.

As in past years, our primary outcome of interest is performance on the NYS Earth Science Regents exam. We use both the standardized z-score (mean of 0 and standard deviation of 1) and the probability of passing at 65 or above and 85 or above; 65 is the passing threshold on the Regents exam while 85 indicates a high pass.

After matching, we estimate the relationship between achievement and having an AMNH RGGS graduate as an Earth Science teacher using the following model:

$$Y_{ijt} = \beta_0 + \beta_1 RGGS_j + \beta_2 (RGGS*year)_{ijt} + \beta_3 ST_{it} + \gamma_t + \varepsilon_{ijt} \quad (1)$$

In this model, Y is the outcome of interest (either passing at 65 or above, passing at 85 or above, or the z-score for the Earth Science Regents) for student *i* taught by teacher j in year *t*. *RGGS* is an indicator variable and takes a value of 1 if student *i* is taught by *RGGS* teacher *j* and 0 if they are taught by another teacher. *RGGS*year* is an interaction term that indicates whether the student had an AMNH RGGS teacher in a particular year (2014 through 2019 and 2022). *ST* is a set of student characteristics that includes the socio-demographic characteristics, educational needs, and grade indicators described in the data section above. Year effects are indicated by γ and ε indicates the remaining variation due to unobservable or uncontrolled for factors. Robust standard errors clustered by teacher are used and all analyses are weighted using the entropy balance weights. This means that we run the same model on the three outcome variables.

We use an ordinary least squares regression (OLS) for models in which the z-scores in the Earth Science Regents are the outcome of interest (Y); linear probability models (LPM) are used for models in which passing is the outcome of interest (an indicator for passing at either 65 or higher or 85 or higher).

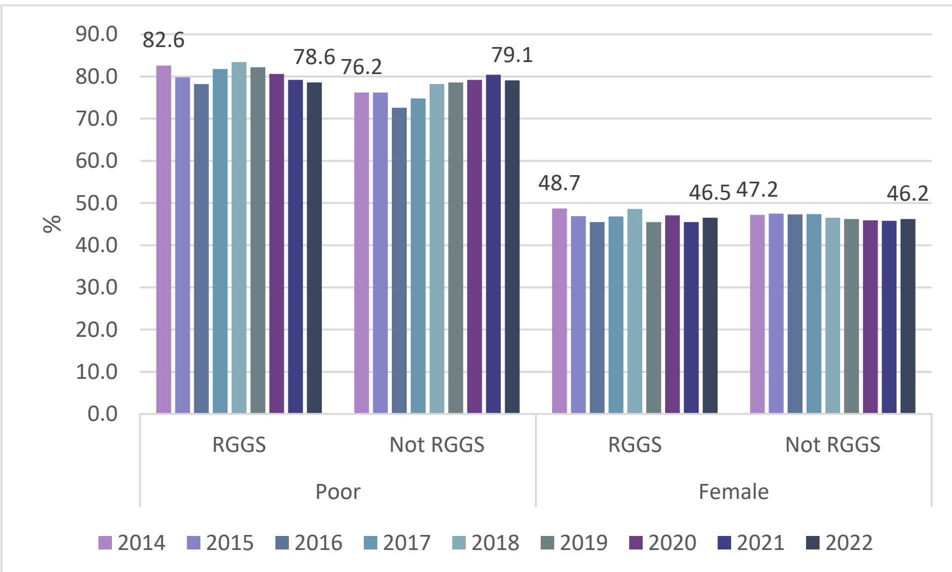
IV. Findings

In Sections A and B we present descriptive analyses on the characteristics of students with AMNH RGGS teachers by year, for students in high school grades (Section A focuses on students in grades 9-12) and students in middle school grades (Section B focuses on students in grades 6-8). We focus on describing variation in demographic characteristics and educational needs among students taught by an AMNH RGGS teacher across time, though we also compare them to students taught by non-AMNH RGGS teachers. In Section C we present the results of our regression analysis.

A. Descriptive Statistics: HS Students Enrolled in Earth Science Courses

Figure IV-1 to Figure IV-16 display the percentage of AMNH RGGS students and non-RGGS students enrolled in high school Earth Science courses with particular demographic and educational characteristics over time. Overall, there has been little change in the characteristics of students taught by AMNH RGGS graduates over time. The share of students who are poor decreased from 82.6% in 2014-15 to 78.6% in 2021-22. However, this is not statistically significantly different from the percentage of poor students not taught by RGGS in 2021-22: 79.1%. The percentage of female students taught by RGGS graduates in 2022 was 46.5 and non-RGGS graduates was 46.2. This percentage is relatively consistent over time.

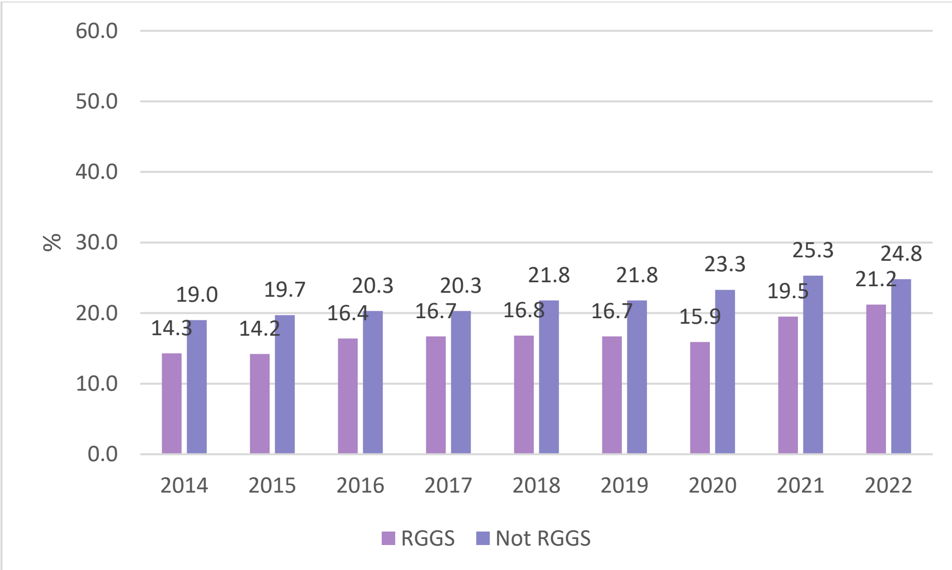
Figure IV-1**. Percent of Poor and Female Students in Grades 9-12 Enrolled in Earth Science by RGGS Status and Year, 2014-22**



Notes: All differences for Poor are statistically significant at $p < 0.05$ except for 2022. Differences for Female are only statistically significant for 2018 at $p < 0.01$.

Figure IV-2 shows the percentage of students with disabilities (SWDs) taught by RGGS graduates and non-graduates. The percentage of SWDs enrolled in Earth Science courses has increased for both groups since 2014. For RGGS graduates, SWDs have increased from 14.3% to 21.2% in 2022. For non-RGGS graduates the percentage of SWDs has increased from 19.0 to 24.8. Annual differences between RGGS and non-RGGS students are statistically significant at $p < 0.01$.

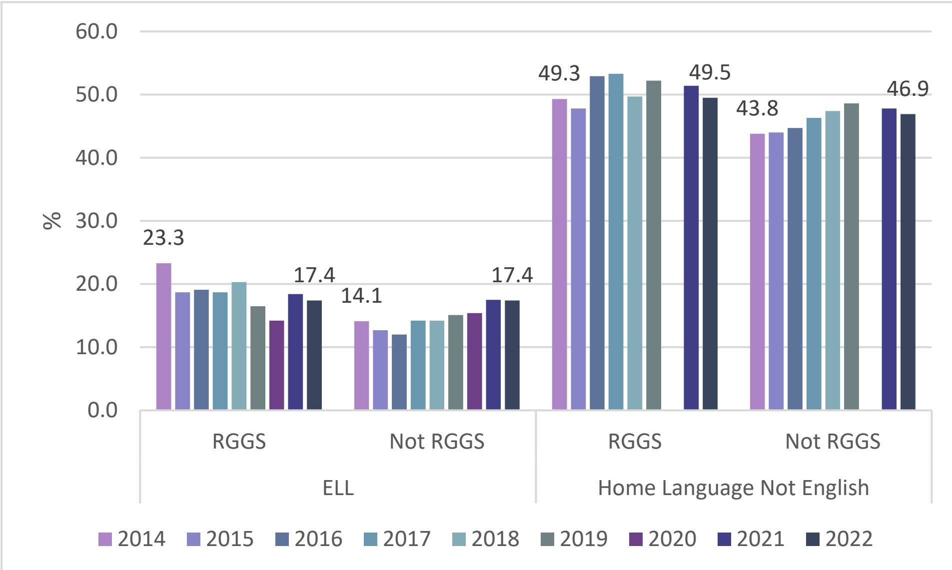
Figure IV-2. Percentage of Students with Disabilities in Grades 9-12 Enrolled in Earth Science by RGGS Status and Year, 2014-22



Notes: Differences are statistically significant for all years at $p < 0.01$

Since 2014, the percentage of ELLs taught by RGGS graduates has decreased from 23.3% to 17.4%, while the percentage taught by non-graduates has increased from 14.1% to 17.4% (Figure IV-3). The differences in the percentage of ELL students between the two groups is not statistically significant in 2020, 2021, or 2022. However, the percentage of students who speak a language other than English at home is higher among RGGS graduates than non-graduates (in 2022 this was 49.5% vs. 46.9%). This percentage has been relatively stable over time and the differences are statistically significant for all years.

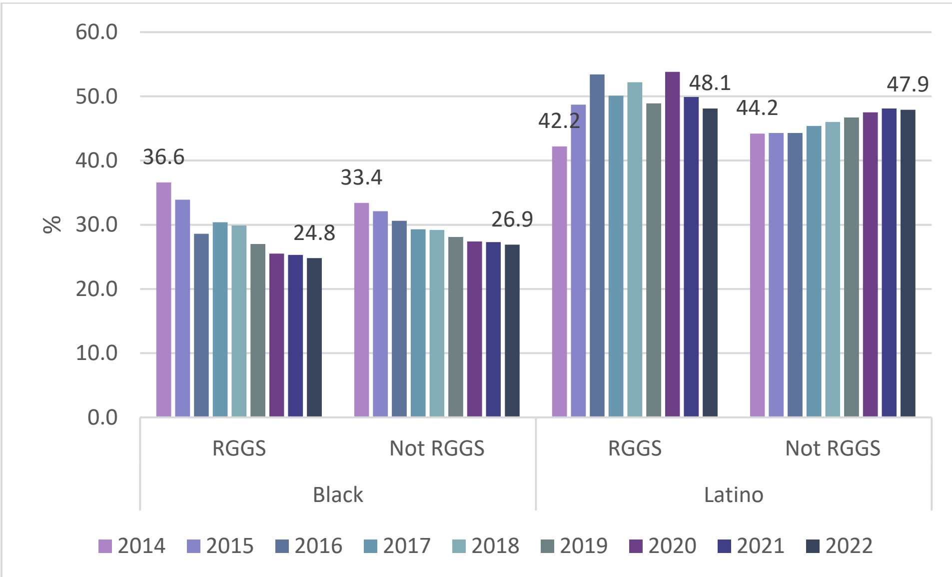
Figure IV-3. Percentage of Students by ELL and Home Language Not English in Grades 9-12 Enrolled in Earth Science by RGGS Status and Year, 2014-22



Notes: All differences are statistically significant for ELL at $p < 0.05$ except for 2020, 2021, and 2022. Differences for Home Language are statistically significant at $p < 0.001$ for all years. Home language other than English is not available for 2020.

As shown in Figure IV-4 the percentage of Black students enrolled in Earth Science courses has decreased since 2014, which likely reflects the decrease in the percent of Black students enrolled in NYC public schools. In 2022, the percentage of Black students taught by RGGS graduates was 24.8% compared to 26.9% taught by non-RGGS graduates ($p < 0.01$). However, as the percentage of Black students decreased, the percentage of Latino students has increased. In 2022, 48.1% of students taught by RGGS graduates were Latino, compared to 47.9% taught by non-RGGS graduates. This difference is not statistically significant.

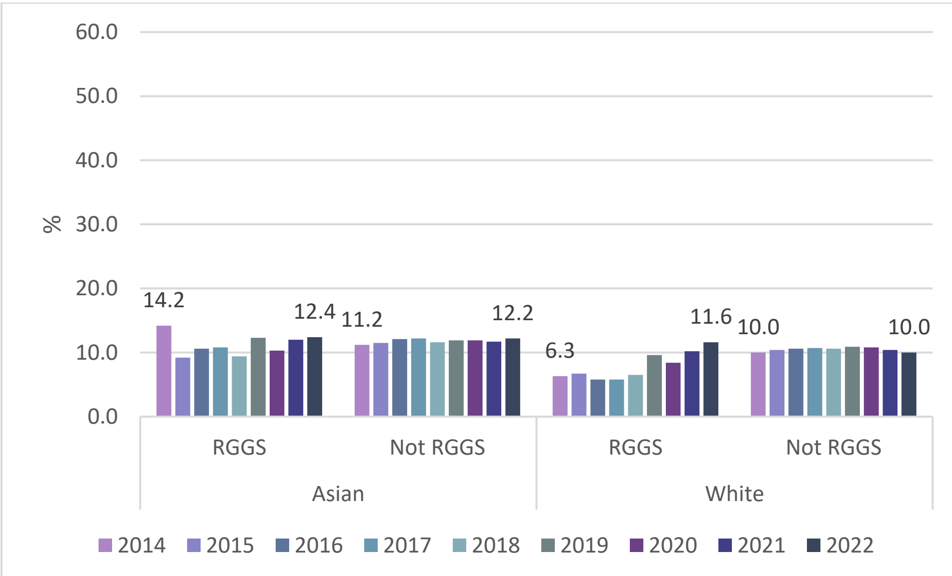
Figure IV-4. Percentage of Black and Latino Students in Grades 9-12 Enrolled in Earth Science by RGGS Status and Year, 2014-2022



Notes: Differences for Black are statistically significant at $p < 0.05$ for 2016 and 2020-2022. Differences for Latino are statistically significant at $p < 0.05$ for all years except 2014 and 2022.

The percentage of Asian and White students taught by RGGS and non-graduates is shown in Figure IV-5. The percentage of Asian students taught by RGGS graduates has decreased to 12.4% in 2022 from 14.2% in 2014, while the percentage of Asian students taught by non-graduates increases from 11.2% to 12.2%, although in most years, the percentage of Asian students taught by RGGS graduates was lower than those taught by non-RGGS graduates. The percentage of White students taught by RGGS graduates has increased to 11.6 in 2022 from 6.3 in 2014, while the percentage of White students taught by non-RGGS graduates has consistently remained about 10%. All differences between RGGS and non-RGGS students are statistically significant at $p < 0.01$, except for 2021.

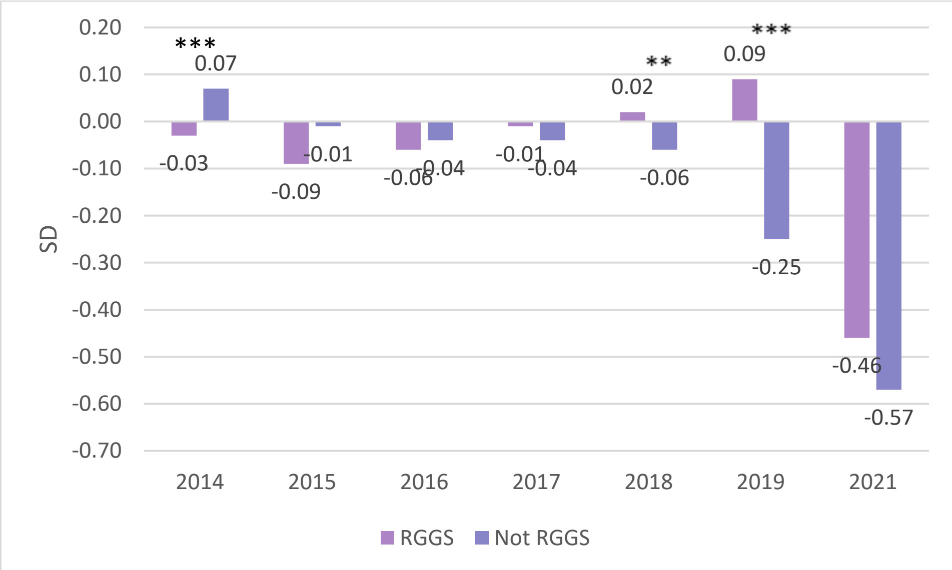
Figure IV-5. Percentage of Asian and White Students in Grades 9-12 Enrolled in Earth Science by RGGS Status and Year, 2014-2022



Notes: Differences for Asian are statistically significant at $p < 0.05$ for all years except 2019 and 2022. Differences for White are statistically significant at $p < 0.001$ for all years except 2019 and 2021.

Our measure of past performance are z-scores on the 8th Grade ILS Exam, given in the spring of 8th grade. As Figure IV-6 shows, in most years, on average, all students who were enrolled in Earth Science courses in high school scored below the citywide average. In some years, for example, 2015 and 2016, students of RGGS graduates scored lower than those of non-RGGS graduates (although these differences are not statistically significant), while in other years, for example, 2019 and 2021, students of RGGS graduates scored higher, although in 2021 they still score below the citywide average. These results are similar if we limit the sample to just those students who took the Earth Science Regents in high school.

Figure IV-6. Z-score on 8th Grade Intermediate Level Science exam by RGGS status and Year, Grades 9-12, 2014-2022



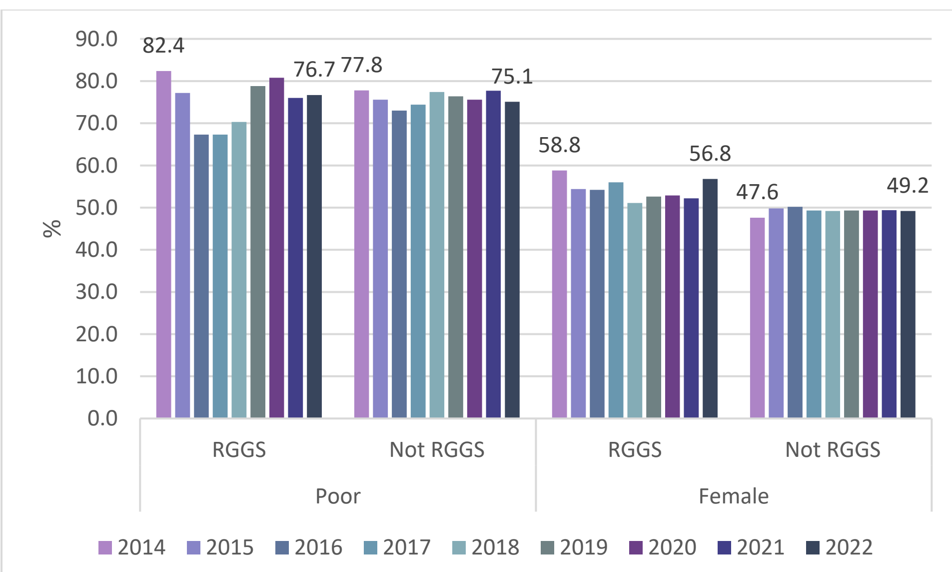
Notes: The 8th grade ILS was not administered in 2020
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

B. Descriptive Statistics: Students in Grades 6-8

We undertook a separate descriptive analysis of students in grades 6-8 for the current report. In this analysis it is harder to identify a comparison group because most middle school RGGS teachers teach a general science course, rather than a specific Earth Science course. To find a similar group of students we limited our comparison to students of non-RGGS teachers with similar years of experience in each year to our RGGS graduates and who taught similar courses. For example, for 2022 we included students of all non-RGGS teachers who taught Earth Science or General Science and have fewer than 8.2 years of experience at the DOE (rather than simply limiting to students in Earth Science courses taught by non-RGGS teachers, as we did for the analyses of grades 9-12 in Section A). In 2014, we only included students of non-RGGS teachers who had fewer than 0.2 years of teaching experience at NYC DOE.

Figure IV-7 shows the percentage of students who are poor or female by RGGS status and year. We see that the percentage of poor students taught by RGGS graduates decreased over time to 76.7% in 2022 from 82.4% in 2014. However, in each year since 2014, RGGS graduates have taught a higher percentage of poor students in grades 6-8 than non-RGGS graduates, although these differences are only statistically significant in some years. RGGS graduates also taught a higher percentage of female students in each year compared to non-RGGS teachers. For example, in 2014 58.8% of students of RGGS graduates were female, compared to 47.6% for students of non-RGGS graduates ($p < 0.001$), while in 2022 56.8% of students taught by RGGS graduates were female, compared to 49.2% for non-RGGS graduates ($p < 0.001$).

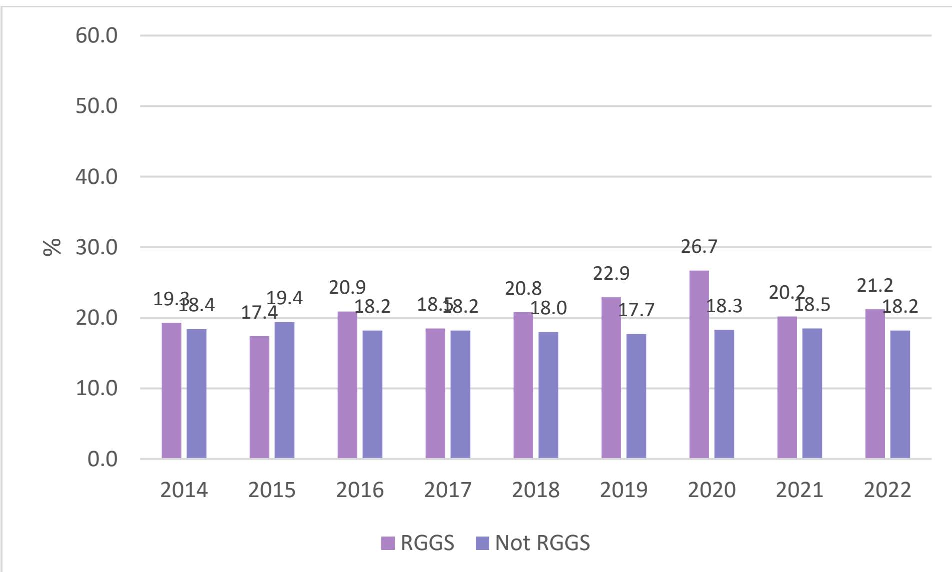
Figure IV-7. Percentage of Poor and Female Students in Grades 6-8 by RGGS Status and Year, 2014-2022



Notes: Differences for Poor are statistically significant at $p < 0.05$ for all years except 2015, 2021, and 2022. Differences for Female are statistically significant at $p < 0.05$ for all years except 2015 and 2018.

Figure IV-8 presents the percentage of SWDs by RGGS status and year. In most years RGGS graduates taught a higher percentage of students with disabilities compared to non-RGGS graduates, although the differences are not statistically significant in all years. While the percentage of SWDs taught by RGGS graduates has increased slightly over time (to 21.2% in 2022 from 19.3% in 2014), it has remained relatively stable (at about 18%) for non-RGGS graduates.

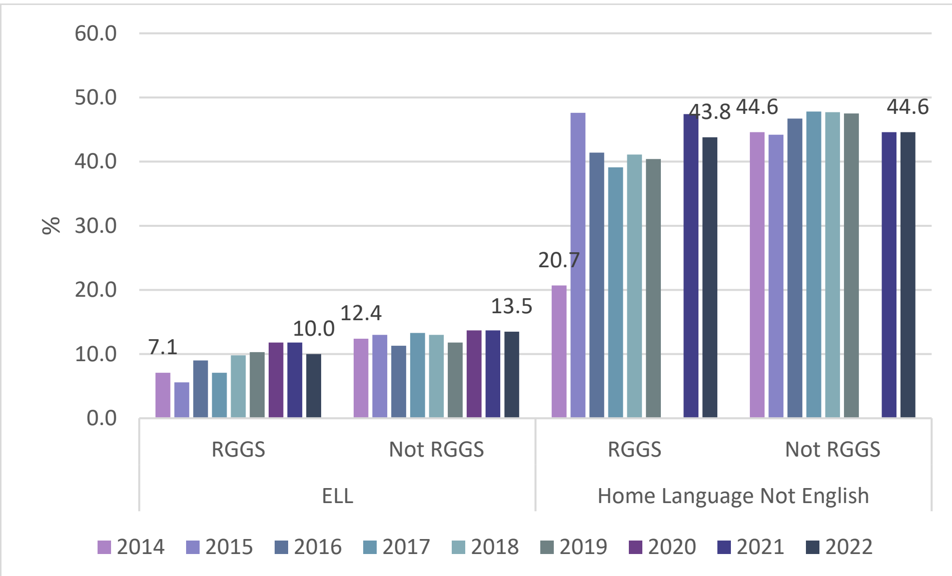
Figure IV-8. Percentage of Students with Disabilities in Grades 6-8 by RGGS Status and Year, 2014-22



Notes: Differences are statistically significant at $p < 0.01$ for 2018, 2019, 2020, and 2022.

The percentage of ELLs taught by RGGS graduates is lower in each year when compared to non-RGGS graduates (Figure IV-9). In 2014, 7.1% of students of RGGS graduates were ELLs compared to 12.4% of students of non-RGGS graduates ($p < 0.01$), while in 2022 10% of students of RGGS graduates were ELL compared to 13.5% for non-RGGS graduates ($p < 0.001$). However, RGGS graduates also teach a high percentage of students who have a home language other than English. In 2022, 43.8% of students of RGGS graduates had a home language other than English, compared to 44.6% for non-RGGS graduates.

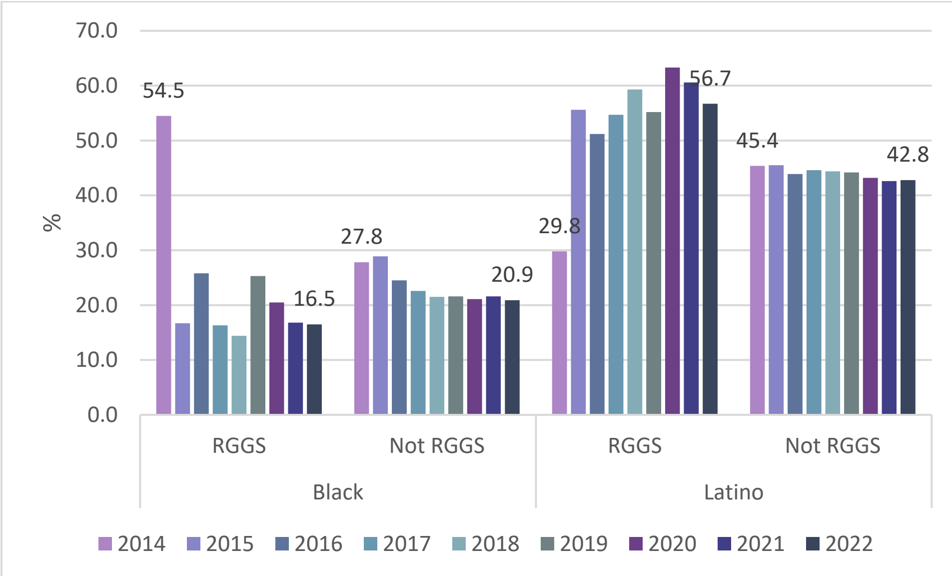
Figure IV-9. Percentage of ELL and Home Language Other than English by RGGS Status and Year, Grades 6-8, 2014-22



Notes: All differences for ELL are statistically significant at $p < 0.05$, except for 2016 and 2019. Differences for Home Language Other than English are statistically significant at $p < 0.05$ for all years except for 2015 and 2022. Home Language not available for 2019-20.

While over half of students taught by RGGS graduates were Black in 2014, compared to 27.8% for non-RGGS graduates, this has decreased to 16.5% and 20.9%, respectively, in 2022 (Figure IV-10). For Latino students, it is the opposite. In 2014, 29.8% of students taught by RGGS graduates were Latino, compared to 45.4% for non-RGGS graduates ($p < 0.001$). In 2022, the percentage of Latino students taught by RGGS graduates was 56.7 compared to 28.8 for non-RGGS graduates.

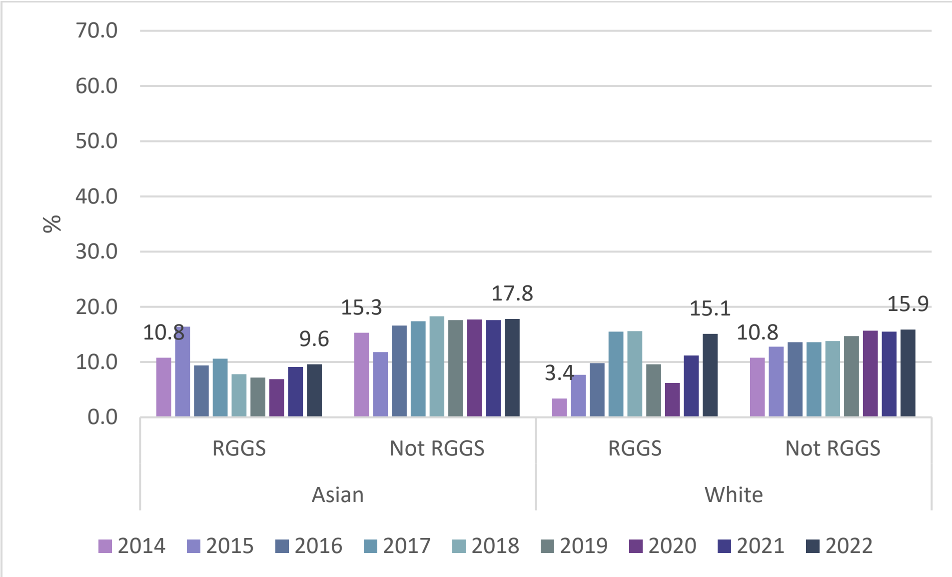
Figure IV-10. Percentage of Black and Latino Students by RGGS Status and Year, Grades 6 to 8, 2014-22



Notes: All differences for Black are statistically significant at p < 0.05, except for 2016 and 2020. All differences for Latino are statistically significant for all years at p < 0.001.

RGGS graduates who teach students in grades 6-8 teach, in general, a lower percentage of Asian and White students compared to non-RGGS graduates (Figure IV-11). In 2014, 10.8% of students taught by RGGS graduates were Asian compared to 15.3% of students taught by non-RGGS graduates ($p < 0.05$). In 2022, the percentages were 9.7% and 17.8% respectively ($p < 0.001$). For White students, the percentage taught by RGGS graduates varies by year from a low of 3.4% in 2014, to a high of 16.4% in 2017 and 2018, while the percentage of White students taught by non-RGGS graduates ranged from 10.8% to 15.9%. In 2022, the percentage for both groups were 15.4% and 15.9%.

Figure IV-11. Percentage of Asian and White Students by RGGS Status and Year, Grades 6 to 8, 2014-22



Notes: All differences for Asian are statistically significant at $p < 0.05$. All differences for White are statistically significant for all years at $p < 0.01$ except for 2017, 2018, and 2022.

The percentage of students in 7th and 8th grade who take the Earth Science Regents are small (fewer than 2,000 over the years of this study and fewer than 30 RGGS students in any year). However, we do see that among 8th grade students, students with RGGS teachers are more likely to take the exam than those without RGGS teachers (8.3% vs. 1.5%, $p < 0.001$). Students of RGGS teachers also scored higher (0.44 sd compared to 0.22 sd, $p < 0.01$) and are more likely to pass at 65 or higher (64.1% compared to 55.7%, $p < 0.01$) or 85 or higher (33.1% compared to 28.4%, not statistically significantly different). These numbers are too small to disaggregate by year. We see no statistically significant difference in z-scores on the 8th grade Intermediate Level Science exam between the two groups.

C. Regression Analyses

In this section, we present the regression analyses on the impact of having an AMNH RGGS teacher on Earth Science Regents outcomes for years 2014 – 19 and 2022. Table IV-1 summarizes the data used for the regression analyses, presented in Figures IV-12 to IV-14.

Table IV-1. Summary of Regression Analyses

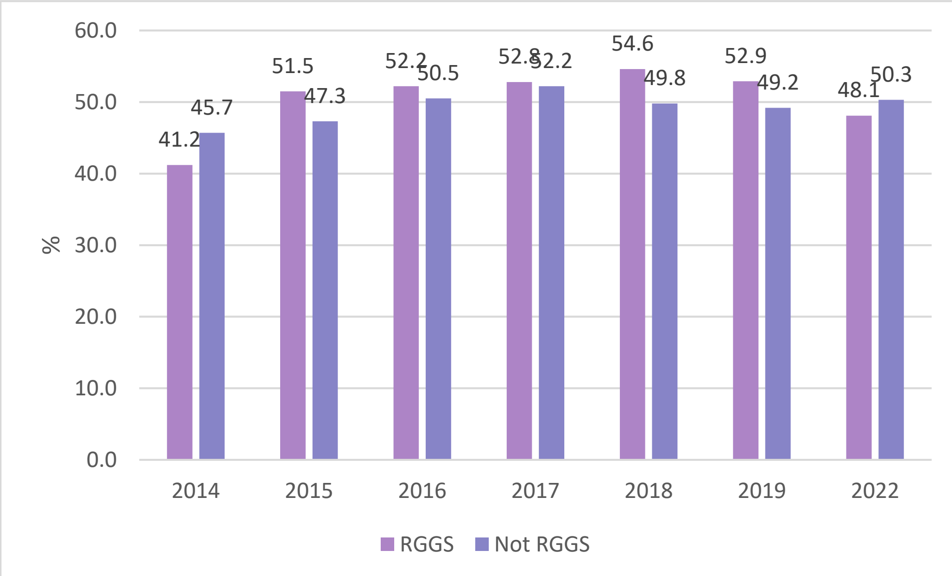
	Outcome Variables
Cohorts	1-9
# years student data	1-7
Includes Student Characteristics	Yes
Includes Prior Performance	Yes
Includes Year Effects	Yes

Notes: Earth Science Regents were not given in 2019-20 and 2020-21 because of the COVID-19 pandemic

We show the results comparing the treatment and comparison group results in Figures IV-12 to IV-14 (see Appendix Figure IV-2 for other visualizations of results with confidence intervals). As mentioned previously, this analysis compares NYC public school students of AMNH RGGS teachers to similar students not taught by an AMNH RGGS teacher and who are matched on observable student, teacher, and school observable.

Figure IV-12 shows the percentage of students in each group who take the Earth Science Regents, before the match. In 2016-2019, over half of students enrolled in Earth Science courses take the Regents, regardless of RGGS status. We see that students of RGGS graduates are more likely to have taken the Earth Science Regents than other students, except in 2014 and 2022. However, these differences are only statistically significant ($p < 0.01$) for 2015, 2018, 2019, and 2022.

Figure IV-12. Percentage of Students Enrolled in Earth Science Course in Grades 9-12 who Take the Earth Science Regents, 2014-2019 and 2022

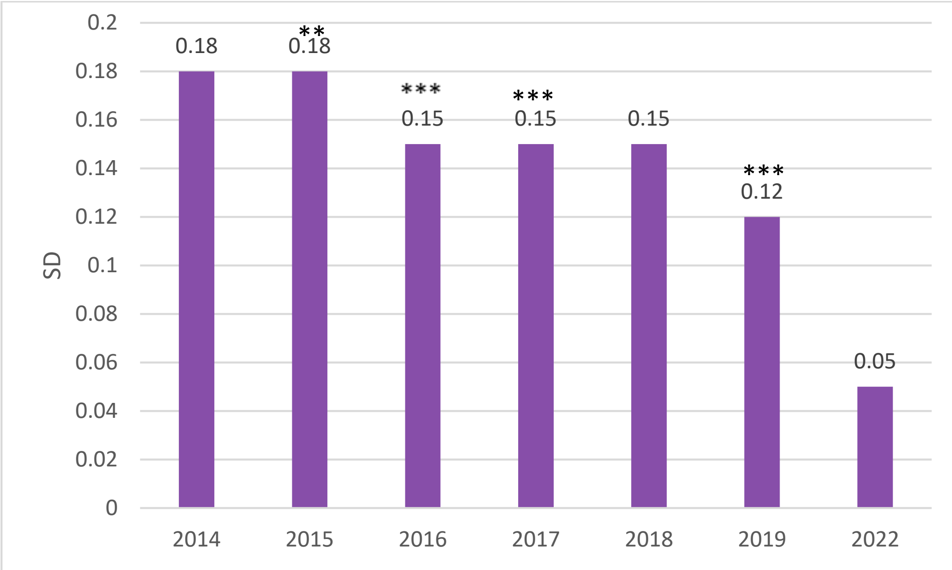


Notes: Differences are statistically significant at $p < 0.01$ in 2014 and 2015, 2018, 2019, and 2022.

Figures IV-13 and IV-14 show the marginal effects for students of RGGS graduates on the Earth Science Regents z-score, passing at 65 or higher, and passing at 85 or higher. Marginal effects indicate the difference between RGGS students and non-RGGS students in each year, holding all other variables constant.

RGGS students outperform non-RGGS students on the z-score in each year, although the differences are only statistically significant for 2015-2019. In these years, students score between 0.12 and 0.18 standard deviations (sd) higher than non-RGGS students. This is comparable to a score increase of between 2.1 and 2.8 points on the exam, which, if it entails movement around the passing thresholds, will enable students to pass. In 2022, a 0.05sd increase moved student scores up by 1 point from 57.4 to 58.4.

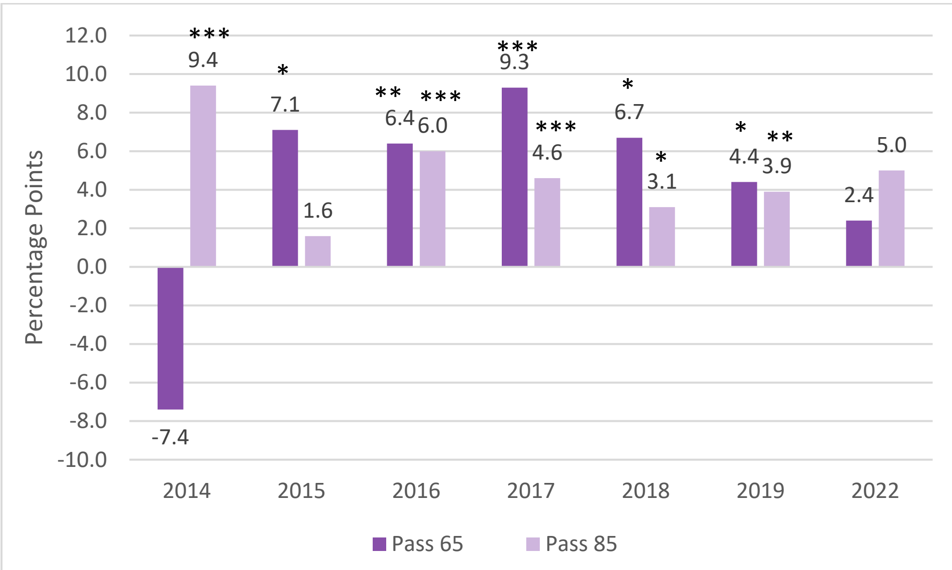
Figure IV-13. Marginal Effects, Earth Science Regents 2014-2019 and 2022, Matched Sample



Sample is all students in grades 9-12 who were enrolled in Earth Science and took the Earth Science Regents exam in the same year.
N = 30,153
Robust standard errors clustered by teacher.
Covariates not shown are: Grade, 8th grade ILS z-score, Black, Latino, Asian, Female, Poor, SWD, ELL, and home language other than English.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The results for passing the Earth Science regents at 65 or higher and 85 or higher are shown in in Figure IV-14. As expected**,** based on the results with z-scores as the outcome, RGGS students are statistically significantly more likely to pass at 65 or higher for all years except 2014 and 2022. They are statistically significantly more likely to pass at 85 or higher for all years except 2015 and 2022. The improved likelihood of passing at 65 or higher for RGGS students ranges from 4.4 percentage points in 2019 to 9.3 percentage points in 2017. This translates to approximately 81 more students passing in 2019 and over 175 more students passing in 2017; in 2022, the number of additional students passing at 65 or higher is 55. The improved likelihood of passing at 85 or higher is similar, ranging from 1.6 and 6.0 percentage points, which translates to between 17 and 94 additional students passing at 85 or higher. In 2014, however, students of non-RGGS graduates were more likely to pass at 85 or higher than students of RGGS graduates. In 2022, 5.0 percentage points translates into 116 additional students passing at 85 or higher.

Figure IV-14. Marginal Effects of Scoring 65 or 85 or higher on the Earth Science Regents, 2014-2019 and 2022



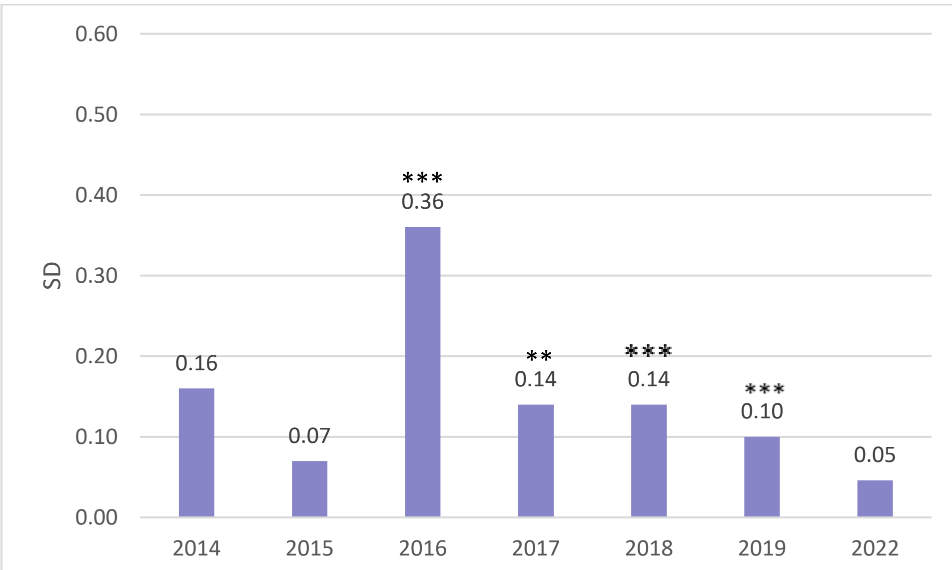
Sample is all students in grades 9-12 who were enrolled in Earth Science and took the Earth Science Regents exam.
N = 30,153
Robust standard errors clustered by teacher.
Covariates not shown are: Grade, 8^{th} grade ILS z-score, Black, Latino, Asian, Female, Poor, SWD, ELL, and home language other than English
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Robustness Checks

Because of the limitations of the 2021-22 data, two robustness checks were conducted. The first robustness check limits the analysis to students of RGGS teachers in Cohorts 1-6 since they are more likely to have more than one year of Regents test scores, unlike RGGS graduates from Cohorts 7-9 who are limited to just one year of test scores because of the pandemic. These students are again matched on observable student, teacher, and school characteristics to obtain the appropriate treatment and comparison groups (n=14,336).

We see similar results to our full sample, although the coefficients for 2016 are more than twice as high as those in the full sample and for 2017-19 are slightly lower (0.01- 0.02 sd). In terms of statistical significance, only 2015 differs (it is not statistically significant in this robustness check but is statistically significant in the full sample).

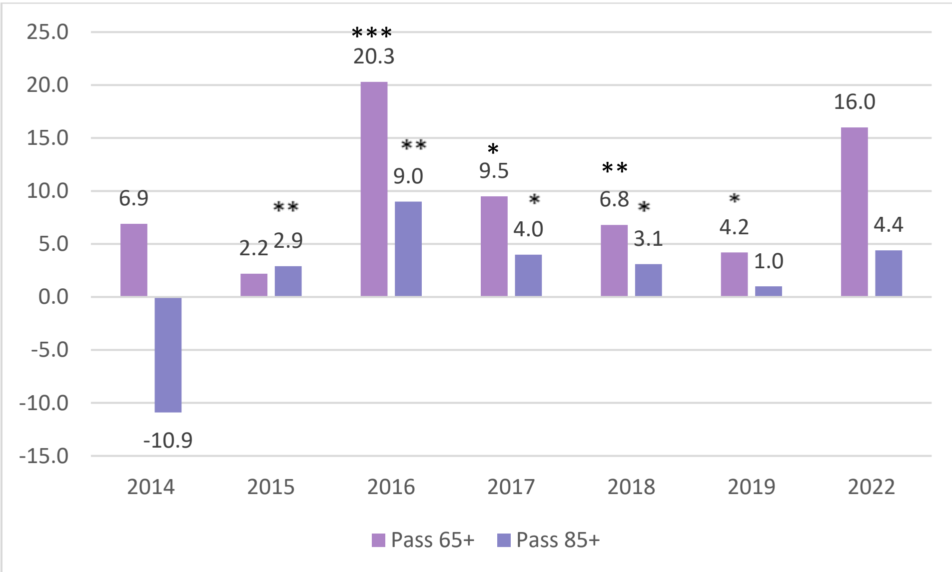
Figure IV-15. Marginal Effects, Z-Scores Earth Science Regents, Cohorts 1-6 only



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

A higher percentage of RGGS students pass at both levels compared to the results from our full analysis. Statistical significance is similar except for passing at 85 or higher, which is now statistically significant for 2016 and not significant in 2019. Additionally, the percentage point differences are higher in this sample for most years (especially in 2016 and 2017) than the full sample.

Figure IV-16. Marginal Effects of Scoring 65 or 85 or higher on the Earth Science Regents, 2014-2019, Cohorts 1-6 Only



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

The second robustness check focuses only on 2022 and does not include z-scores (measure of past performance) for the 8th grade ILS exam because they are not available for the majority of students in our sample. The sample for 2022 without including past performance in science as a match variable enables us to put together a well-matched comparison group (See Appendix Figure VI-1, H). Additionally, the number of observations that included in 2022 increased to 6,833 from 669.

The results indicate that the average z-score for RGGS students was 0.07sd and is statistically significant, unlike the results using the full sample. RGGS students were also 3.0 percentage points more likely to pass at 65 or higher and 85 or higher, both of which are statistically significant. However, because we lacked data on past performance, it is likely there are unobserved differences between RGGS and non-RGGS students on past performance in science.

V. Conclusion

This report presents the results on AMNH's RGGS Earth Science Residency Program. To recap, we again use data obtained from the NYCDOE to examine the impact of AMNH RGGS on student performance on the NYS Earth Science Regents exam using a comparison group of students who are matched to AMNH RGGS students on student characteristics, teacher characteristics, and characteristics of the schools they attend. The results presented in this report contain analyses on 9th to 12th graders who were enrolled in Earth Science courses in 2013-14 through 2021-22 and include graduates from cohorts 1-9. Separate descriptive analyses were conducted on students in 6th to 8th grade.

We find that AMNH graduates continue to teach NYC public school students who are poor, Black, Latino, those with disabilities, English language learners and those who have a home language other than English and are not leaving these students in favor of better schools as they gain teaching experience and seniority in the DOE. This is an important finding, given that the harmful effects of teacher turnover are well-documented: including increasing the number of inexperienced teachers in the school, reductions in student achievement, disruptions in school-community relationships, and increasing school costs to replace these teachers (Atteberry et al, 2017; Adnot et al, 2016; Hanushek et al, 2016; Ronfeldt, et al, 2013; Sorensen et al, 2020; Watlington et al, 2010). It is especially difficult to recruit and retain science teachers and those teaching in middle school (Guarino et al., 2004; Ingersoll, 2003; Marinell & Coca, 2013; Nguyen et al., 2020; Nguyen et al., 2022; Nguyen & Redding, 2018). In NYC, a quarter of teachers leave their schools within one year of entering the workforce, and more than one-half leave within the first three years (Marinell & Coca, 2013). Additionally, the cost of teacher turnover is high. In 2004, the United Federation of Teachers estimated that the cost of a first-year NYC teacher leaving the district was $13,200. Therefore, the AMNH RGGS program is serving a population with particularly high attrition rates.

The results also show that students of AMNH RGGS graduates are outperforming other NYC public school students who take the NYS Earth Science Regents exam. In general, RGGS students perform higher on the Earth Science Regents exam than their matched counterparts in all years, and were statistically different from scores of non-RGGS students in 2015 through 2019. Overall, RGGS students perform between 0.05 and 0.18 standard deviations higher than those in the comparison group. These groups are also more likely to pass at 65 or higher and 85 or higher compared to their counterparts, except for the first year of the program.

The Covid-19 pandemic has presented limitations in our continued analysis of the AMNH RGGS program. First, NYS Regents exams were not given in the 2019-20 and 2020-21 schools years and students did not need to make up exams for graduation. Therefore, we have limited data on students taught by teachers in cohorts 7 and 8 and only begin to see the how their students are doing in their 2nd and 3rd year of teaching. To account for this, we conduct a separate analysis limited to RGGS graduates in cohorts 1-6. Results from this are similar to our full sample, although the coefficients for 2016 are more than twice as high as those in the full sample (0.36sd vs 0.15sd, p, < 0.001). Secondly, the 8th grade exam, which we use as a measure of past performance, was also suspended in 2019-20. Therefore, the results from 2021-22 are based on a small number of students (fewer than 700) who had taken Earth Science Regents and have 8th grade ILS scores. To account for this limitation, we conducted a separate analysis of 2021-22 results without controlling for past performance (n=6,833). The results showed that RGGS students score 0.07sd higher than other students. However, it is likely that there are unobserved differences between RGGS and non-RGGS students that are not controlled for in this analysis.

Because of the limited sample for 2022 we were unable to conduct subgroup analyses but hope to include these in the Year 10 report. Additionally, cohorts 7-9 will have two years of test score results, which will give us more data points in which to evaluate graduates in these cohorts.

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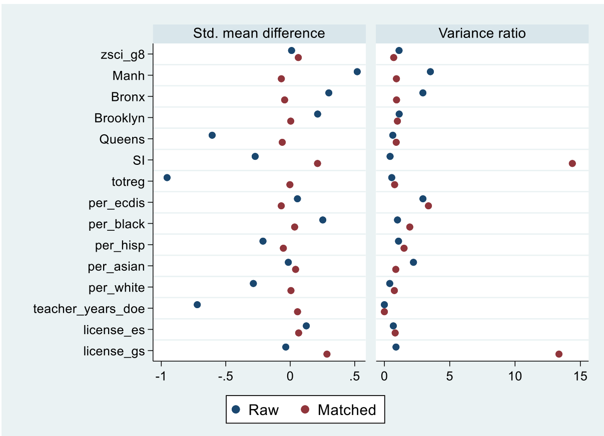
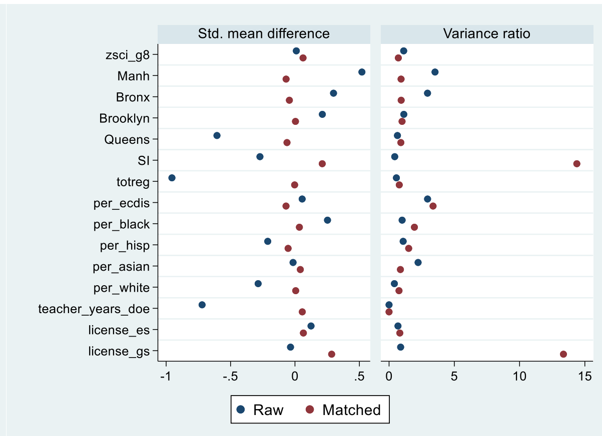
VI. Appendices

Figure VI -1. Balance Results for KMATCH for Treatment and Comparison Group by Year

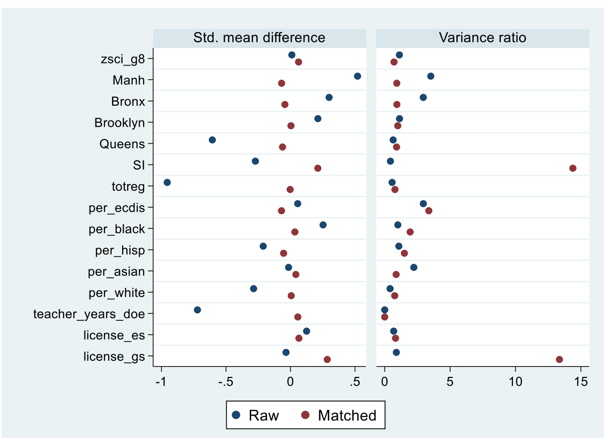
Year 2014



Year 2015



Year 2016



Year 2017

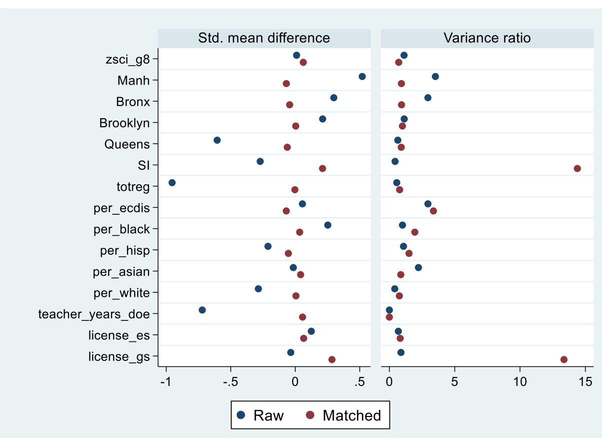
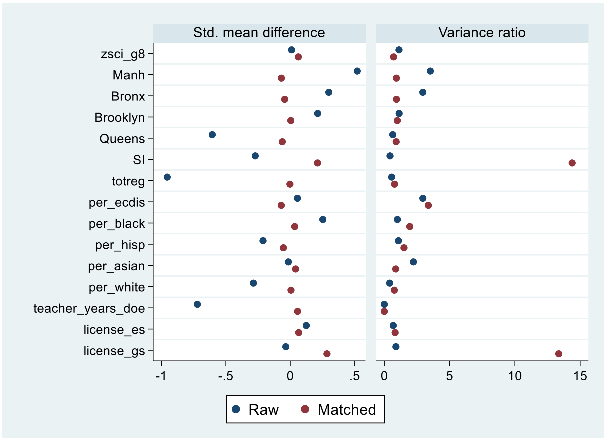
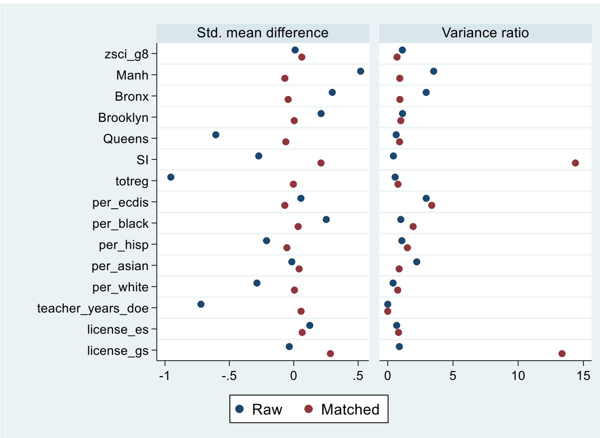


Figure VI -2. Balance Results for KMATCH for Treatment and Comparison Group by Year (cont.)

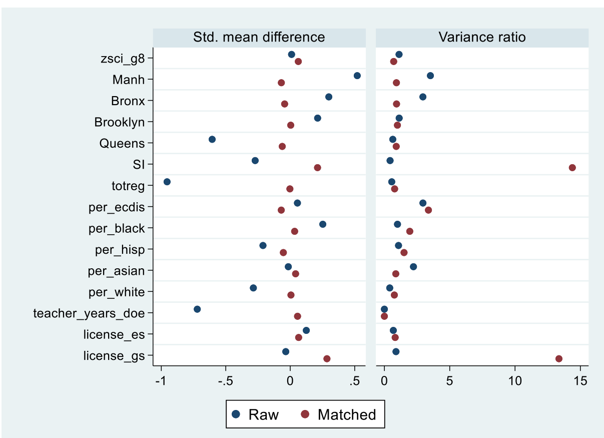
Year 2018



Year 2019



Year 2022



Year 2022 without 8th grade ILS scores

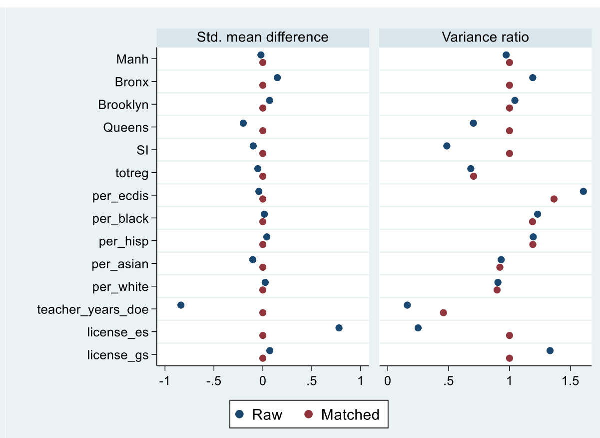
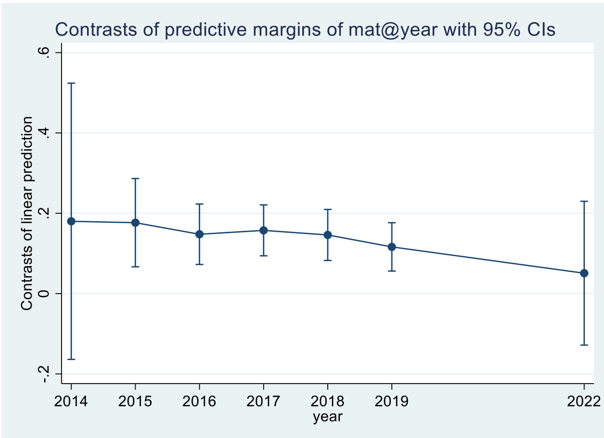
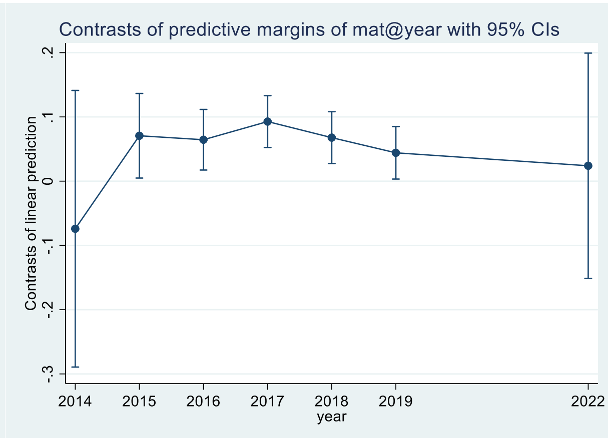


Figure VI-2. Earth Science Regents Results, All Cohorts

Earth Science Regents Z-Scores



Pass at 65 or higher



Pass at 85 or higher

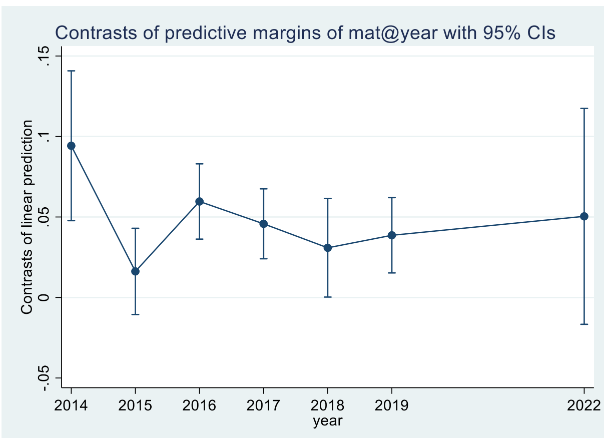
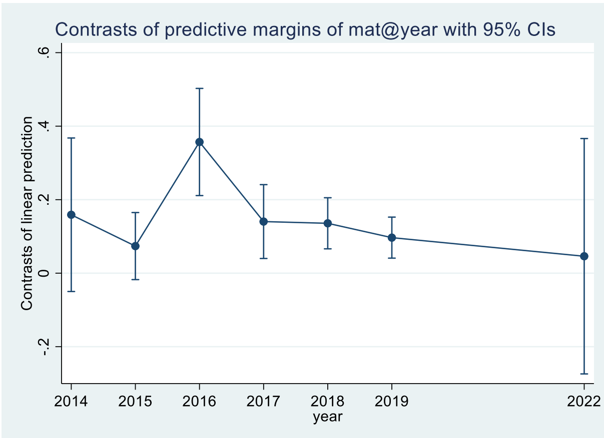
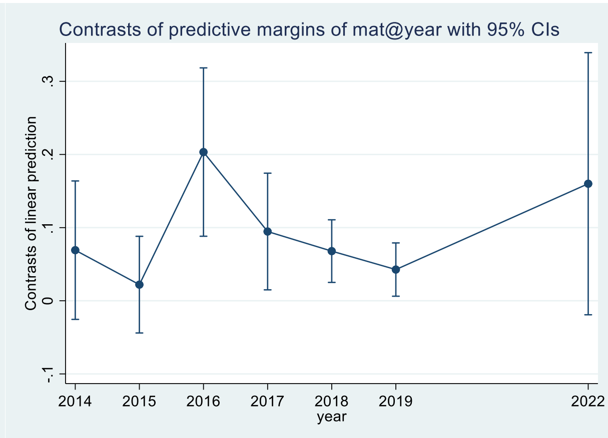


Figure VI-3. Earth Science Regents Results, Cohorts 1-6 Only

Z-scores



Passing at 65 or higher



Passing at 85 or higher