

UPDATES – PHYSICS PRAXIS DATA ANALYSIS

Prepared for the New Jersey Center for Teaching and Learning

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In the following report, Hanover Research analyzes performance outcomes on the Praxis chemistry and physics assessments among students prepared by the New Jersey Center for Teaching and Learning (CTL) and those prepared by other institutions in New Jersey (NJ) and across the United States. Differences in the representation of minority and female students across these groups are also examined.

Source: Derived from data provided by Educational Testing Service

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EXECUTIVE SUMMARY AND KEY FINDINGS

INTRODUCTION

In the following report, Hanover Research analyzes performance outcomes on the Praxis chemistry and physics assessments among students prepared by the New Jersey Center for Teaching and Learning (CTL) and those prepared by other institutions in New Jersey and across the United States. Differences in the representation of minorities and women across these groups are also examined.

The analyses presented in this report test six hypotheses:

1. Candidates in the CTL teacher endorsement program perform as well on the Praxis chemistry and physics exams as other test takers in NJ and other states.
2. Candidates in the CTL teacher endorsement program perform as well on each subsection of each exam as compared to other test takers in NJ and other states.
3. Candidates in the CTL teacher endorsement program pass the Praxis chemistry and physics exams at rates similar to other test takers in NJ and other states.
4. Candidates in the CTL teacher chemistry and physics endorsement programs are more ethnically diverse than other test takers in NJ and other states.
5. Candidates in the CTL teacher chemistry and physics endorsement programs are more gender diverse than other test takers in NJ and other states.
6. Minority and female candidates in the CTL endorsement programs perform as well on the Praxis exams as test takers in NJ and other states.

To test these hypotheses, there are five outcome variables of interest:

1. Whether a test-taker passed an exam
2. Whether a test-taker passed an exam on the first attempt
3. Exam scores (overall scaled score and section scores)
4. Proportion of minority students
5. Proportion of female students

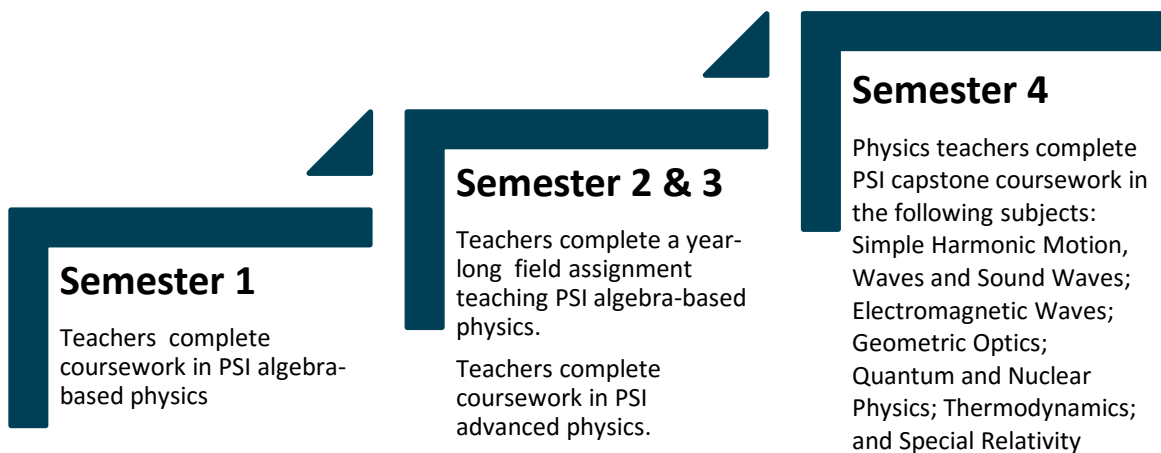
The report is divided into four sections. The table below indicates which hypotheses are tested and the outcome variable(s) of interest by section.

Figure ES.1: Section Descriptions

SECTION	HYPOTHESES TESTED	OUTCOME VARIABLE(S)
Section I: Passing Rates	Hypotheses 1, 3 & 6	Passed exam; Passed exam on first attempt
Section II: Scores	Hypotheses 1, 2 & 6	Exam scores (overall and by section)
Section III: Minority Representation	Hypothesis 4	Proportion of minority students
Section IV: Gender Diversity	Hypothesis 5	Proportion of female students

CTL TEACHER ENDORSEMENT PROGRAM

The New Jersey Center for Teaching and Learning (CTL) is a non-profit organization whose mission is to *empower teachers to lead change so that all children have access to a high quality education*. In 2009, CTL began offering teacher endorsement programs in physics to provide more students access to physics courses. The program is open to teachers who are already certified to teach another subject within the state of New Jersey and are seeking to expand their skillsets by earning certification in a STEM subject. In 2010, CTL began offering a similar program for teachers seeking a chemistry endorsement. Both endorsement programs require teachers to take over 300 hours of instruction as well as complete a year-long field assignment teaching physics (or chemistry). An example of a full program schedule for the physics endorsement program is summarized below.



To earn full certification, teachers must successfully complete *all* of the coursework and field assignment requirements above and must also pass both the General Science Praxis and the physics or chemistry Praxis. Often, teachers elect to take the Praxis subject exams prior to completing all coursework to become familiar with the testing format or expedite the certification process. Once teachers have successfully met all of these requirements, they are able to submit for full physics or chemistry certification, which will allow them to teach any physics or chemistry course in the state of New Jersey. For more information about CTL's physics and chemistry teacher endorsement programs, please visit [CTL's website](#).

RESEARCH METHODOLOGY

Three different types of analyses are employed to test these hypotheses:

- In **Section I: Passing Rates**, since the outcome variables of interest are both binary (passed/did not pass and passed on first attempt/did not pass on first attempt), logistic regression models are used.

- In **Section II: Scores**, because the outcome variables of interest are continuous, linear regression models are used.
- In **Section III: Minority Representation** and **Section IV: Gender Diversity**, Chi-square and Fisher's Exact tests of independence are employed to evaluate whether differences in the proportions of women and minorities across groups (CTL, New Jersey, and United States) are statistically significant.

For all regression models, both logistic and linear, four predictor variables are included:

- **New Jersey** – coded 1 if a test-taker took the test in New Jersey but is not a CTL student, otherwise it is coded 0
- **United States** – coded 1 if a test-taker is not a CTL student and took the test in a state other than New Jersey, otherwise it is coded 0
- **Female** – coded 1 if the test-taker is female and 0 if the test-taker is male
- **Minority** – coded 1 if the test-taker identified as being of a minority race or ethnicity, otherwise it is coded 0

Note that because the variables CTL, New Jersey, and United States are mutually exclusive, such that any one test-taker can be coded "1" for only one of the three variables, CTL is excluded from the model as the reference group. This means that the estimated coefficients for the New Jersey and the United States variables represent the difference in performance between a non-CTL test-taker from one of those regions and a CTL test-taker.

For physics, we fit two sets of regression models. The first measures only the overall difference between CTL and non-CTL students, while including the "Female" and "Minority" variables as controls allowing us to speak to whether CTL and non-CTL students of the same gender and minority status perform better or worse than each other on these three Praxis exams. The second set of models includes interactions between the CTL/non-CTL indicators and the demographic variables; this allows us to examine the difference between CTL and non-CTL students within each demographic group.

Unfortunately, the relatively small number of CTL students taking the Praxis chemistry exam made it impossible to fit the models with interactions for that exam. With only 20 CTL students taking the exam, examining differences by demographic groups would leave only a handful of students in each category, making it impossible to obtain reliable estimates of the difference between CTL students and other test-takers. With only four to six CTL students in each demographic subgroup, it is impossible to generalize from their results.

KEY FINDINGS

PHYSICS

- **CTL students are as likely to pass the Praxis physics exam as non-CTL students.** However, there are slight differences between CTL students and their non-CTL counterparts in New Jersey and the rest of the U.S. that vary by the passing measure.

Specifically, CTL students are somewhat *less* likely to pass on their first attempt, but slightly more likely to pass overall.

- **Female students are significantly less likely to pass the physics exam compared to male students across all three groups (CTL, NJ, and the U.S.).** On average, female students have lower odds of passing on their first attempt by approximately 22 percentage points, and lower odds of passing overall by around 19 percentage points, compared to male students. These effects are highly significant.
 - A significantly greater proportion of CTL students who take the physics exam are female (48%) compared to their non-CTL counterparts in New Jersey (34%) and the rest of the U.S. (38%).
 - Non-minority female CTL students were somewhat more likely to pass the physics exam than non-minority female students from the rest of New Jersey and the U.S., but this difference was only statistically significant when comparing overall (rather than first-time) pass rates between CTL students and non-New Jersey students.
- **Compared to their non-minority peers, minority students are significantly less likely to pass the physics exam across all three groups (CTL, NJ, and the U.S.).** Minority students are less likely to pass on their first attempt and overall by approximately 5 percentage points compared to non-minority students. These effects are highly significant.
 - We note that the differences in the likelihood of passing the physics exam between minority and non-minority students (approximately 5 percentage points), while significant, are substantively lower than the differences between female and male students (19 to 22 percentage points).
 - A significantly greater proportion of CTL students who take the physics exam are minorities (37%) compared to their non-CTL counterparts in New Jersey (20%) and the rest of the U.S. (13%).

CHEMISTRY

- **CTL students are as likely to pass the Praxis chemistry exam as non-CTL students.** In fact, CTL students are *more* likely to pass the chemistry exam by approximately 10 to 14 percentage points, on average, compared to non-CTL students in New Jersey and students in the rest of the U.S. However, these marginal effects at the means are not statistically significant.
- **Compared to their male peers, female students are significantly less likely to pass the chemistry exam across all three groups (CTL, NJ, and the U.S.).** Female students have lower odds of passing on their first attempt by approximately 13 percentage points, and lower odds of passing overall by around 9 percentage points, on average, compared to male students. These effects are highly significant.
 - While a smaller proportion of CTL students who take the chemistry exam are female (50%) compared to their non-CTL counterparts in New Jersey (56%) and the rest of the U.S. (59%), the differences are not statistically significant.

- **Minority students are significantly less likely to pass the chemistry exam across all three groups (CTL, NJ, and the U.S.).** Compared to non-minority students, minorities are less likely to pass on their first attempt by approximately 13 percentage points, and less likely to pass overall by around 11 percentage points, on average. These effects are highly significant.
 - A significantly greater proportion of CTL students who take the chemistry exam are minorities (40%) compared to their non-CTL counterparts in New Jersey (22%) and in the rest of the U.S. (16%).

SECTION I: PASSING RATES

The results presented in this section examine the likelihood of passing the Praxis chemistry and physics exams, based on whether the test-taker is a CTL student, is from New Jersey or somewhere else in the U.S., is female, or is a minority. Likelihood estimates are made both for passing the exams and for passing the exams on the first attempt.

PHYSICS

- **CTL students are as likely to pass the Praxis physics exam as non-CTL students.** CTL students are somewhat less likely to pass on the first attempt but more likely to pass overall. However, the estimated marginal effects of being a non-CTL student in New Jersey or in the rest of the U.S. (compared to being a CTL student) on the likelihood of passing the Praxis physics exam, which range from -6.0 to 5.2 percentage points, are not statistically significant (Figure 1.1).
- **As with the chemistry exams, females and minorities are less likely to pass the Praxis physics exam across all three groups.** It is notable, however, that, compared to the other two exams, the marginal effect of being female on passing the physics exam is substantively larger (-18.8 to -22.0 percentage points) compared to the marginal effect of being of a minority race or ethnicity (-4.8 to -5.4 percentage points) (Figure 1.1).
- **When examining the effect of being a CTL student separately for each demographic group, there are no clear trends in passage rates.** Male minority CTL students are less likely to pass than male minority students in New Jersey and in the rest of the U.S., but these differences are not statistically significant. On the other hand, female non-minority CTL students are more likely to pass than female non-minority students from other areas, though the difference is only statistically significant for the comparison with students from the rest of New Jersey in terms of overall (rather than first-time) pass rate (Figure 1.2).

Figure 1.1: Logistic Regression – Marginal Effects of Gender, Ethnicity, and Being a CTL Student on Passing the Praxis Physics Exam¹

PREDICTOR	PASS	PASS ON FIRST ATTEMPT
New Jersey	-1.1%	5.2%
United States	-6.0%	0.4%
Female	-18.8%***	-22.0%***
Minority	-5.4%***	-4.8%***
Observations	5,803	5,803

Note: * p<0.10; ** p<0.05; *** p<0.01.

Figure 1.2: Logistic Regression with Interactions – Marginal Effects of Being a CTL Student on Passing the Praxis Physics Exam, by Gender and Minority Status⁷

PREDICTOR	PASS	PASS ON FIRST ATTEMPT
Effect of Non-CTL New Jersey Location (vs. CTL)		
Male, Non-Minority	0.1%	6.7%
Male, Minority	6.0%	13.9%
Female, Non-Minority	-7.7%	-2.3%
Female, Minority	-0.9%	4.5%
Effect of Other U.S. Location (vs. CTL)		
Male, Non-Minority	-4.1%	2.1%
Male, Minority	1.8%	9.9%
Female, Non-Minority	-14.4%**	-7.6%
Female, Minority	-6.7%	0.9%
Observations	5,803	5,803

Note: * p<0.10; ** p<0.05; *** p<0.01.

CHEMISTRY

- **CTL students are as likely to pass the Praxis chemistry exam as non-CTL students.** CTL students are somewhat more likely to pass the Praxis chemistry exam compared to students prepared by other programs in New Jersey and the rest of the U.S. – both overall and on the first attempt. However, the estimated marginal effects of being a non-CTL student in New Jersey or in the rest of the U.S. (compared to being a CTL student) on the likelihood of passing the Praxis chemistry exam, which range from 9.9 to 14.2 percentage points, are not statistically significant (Figure 1.3).
- **Female students are significantly less likely to pass the Praxis chemistry exam across all three groups.** After controlling for minority status, participation in the CTL teacher endorsement program, and location, female students are less likely to pass the Praxis chemistry exam on the first attempt by approximately 15.9 percentage points and less

¹ A passing score for the Praxis physics exam in the state of New Jersey is 141. However, we use 134 as the passing score in the analysis, since students who pass the Praxis physics exam with a score of 134 and achieve a GPA of 3.5 can become certified teachers.

likely to pass the exam overall by approximately 12.7 percentage points. Both of these effects are statistically significant at the 0.01 level (Figure 1.3).

- **Similarly, minority students are significantly less likely to pass the Praxis chemistry exam across all three groups.** Compared to their non-minority peers, minority students are less likely to pass the Praxis chemistry exam on their first attempt by approximately 13.2 percentage points and less likely to pass overall by approximately 11.2 percentage points (Figure 1.3).

Figure 1.3: Logistic Regression – Marginal Effects² of Gender, Ethnicity, and Being a CTL Student on Passing the Praxis Chemistry Exam³

PREDICTOR	PASS	PASS ON FIRST ATTEMPT
New Jersey ^{4,5}	-13.4%	-14.2%
United States ^{6,7}	-9.9%	-10.8%
Female	-9.1%***	-12.5%***
Minority	-11.2%***	-13.2%***
Observations	10,416	10,416

Note: * p<0.10; ** p<0.05; *** p<0.01.

² For ease of interpretation, marginal effects are presented instead of the logistic regression coefficients. Marginal effects provide an estimate of the effect the predictor variable has on the outcome variable – in this case the likelihood of passing the Praxis chemistry exam. Those presented here are estimated from holding all variables at their means.

³ A passing score for the Praxis chemistry exam in the state of New Jersey is 152. **However, we use 144 as the passing score in the analysis, since students who pass the Praxis chemistry exam with a score of 144 and achieve a GPA of 3.5 can become certified teachers.**

⁴ The variable “New Jersey” represents students who are from New Jersey but not from CTL.

⁵ Reference Group: CTL students; holds for all subsequent regression models in this report.

⁶ The variable “United States” represents students who are from neither New Jersey nor CTL.

⁷ Reference Group: CTL students; holds for all subsequent regression models in this report.

SECTION II: SCORES

The results presented in this section examine the effect of being a CTL student, being from New Jersey or somewhere else in the U.S., being female, and being a minority on the scores students received on the Praxis chemistry and physics exams. The effects of these variables are estimated for students' overall scaled scores and their individual section scores.

PHYSICS

- Students from other programs in New Jersey scored approximately six points higher on the Praxis physics exam than CTL students.** This effect is significant at the 0.01 confidence level. Non-CTL New Jersey students also scored significantly higher than CTL students on sections four, five, and six of the physics exam (Figure 2.1). We note that CTL students take coursework in the content addressed by sections 4 and 5 of the physics exam during the final semester, *after* they have completed their field experience. Thus, CTL students who take the Praxis without having taught the subjects covered by sections 4 and 5 might be at a disadvantage relative to their peers (who already have a background in physics).
- **The overall scaled scores on the Praxis physics exam of students from elsewhere in the U.S. are not significantly different from those of CTL students.** However, non-CTL U.S. students did score significantly higher than CTL students on sections four, five, and six of this exam (Figure 2.1).
 - **There are not major differences in the gaps between CTL and non-CTL students across different demographic categories.** When examining the effects across demographic groups, patterns for each group are similar to the pattern for all CTL students, though there are fewer significant differences due to the smaller sample size in each group. The most notable difference is in section six: here, male CTL students score 1.6 to 1.7 points lower than other New Jersey and U.S. students, while female CTL students score only 0.7 to 0.9 points lower. No group outperforms other New Jersey or U.S. students in any section by a statistically significant margin (Figure 2.2).
 - **Female students score significantly lower on the Praxis physics exam compared to male students across all three groups.** Holding all other variables constant, female students score approximately 11.93 points lower on the Praxis physics exam than male test-takers, on average. Females also score significantly lower than males on all six sections of the Praxis physics exam (Figure 2.1, Figure 2.2).
 - **Minority students score significantly lower than non-minority students on the Praxis physics exam across all three groups,** but the effect is much smaller compared to that for female students. Minority students score approximately 1.64 points lower on the physics exam, on average – an effect that is significant at the 0.05 confidence level. Minority students also score significantly lower on sections four, five, and six of the physics exam, though the effect is about a third the size of that for women (Figure 2.1, Figure 2.2).

Figure 2.1: Linear Regression – Predicting Overall Scaled Score and Section Scores on Praxis Physics Exam

PREDICTOR	SCALED SCORE	SECTION 1	SECTION 2	SECTION 3	SECTION 4	SECTION 5	SECTION 6
New Jersey	6.08***	0.18	0.59	0.29	1.05***	0.54**	1.24***
United States	3.25	-0.28	-0.21	0.05	0.85***	0.36*	1.29***
Female	-11.93***	-3.03***	-1.78***	-1.14***	-0.63***	-0.64***	-0.68***
Minority	-1.65**	-0.27	0.04	-0.16	-0.23***	-0.24***	-0.21***
Constant	150.58***	21.31***	12.84***	10.14***	4.97***	5.73***	7.41***
Observations	5,803	5,803	5,803	5,803	5,803	5,803	5,803
R-squared	0.074	0.068	0.052	0.034	0.024	0.025	0.037

Note: * p<0.10; ** p<0.05; *** p<0.01. Coefficients estimated using Ordinary Least Squares.

Figure 2.2: Linear Regression with Interactions – Predicting Overall Scaled Score and Section Scores on Praxis Physics Exam, by Gender and Minority Status

PREDICTOR	SCALED SCORE	SECTION 1	SECTION 2	SECTION 3	SECTION 4	SECTION 5	SECTION 6
Effect of Non-CTL New Jersey Location (vs. CTL)							
Male, Non-Minority	7.22**	0.79	0.98	0.25	0.84**	0.38	1.60***
Male, Minority	7.14	0.23	0.59	0.55	0.99**	0.61	1.66***
Female, Non-Minority	4.96	-0.04	0.33	0.17	1.29***	0.58	0.77**
Female, Minority	4.87	-0.60	-0.05	0.47	1.44***	0.81*	0.84**
Effect of Other U.S. Location (vs. CTL)							
Male, Non-Minority	4.53	0.35	0.07	0.09	0.76**	0.25	1.64***
Male, Minority	4.66	-0.32	0.13	0.33	0.74*	0.47	1.71***
Female, Non-Minority	7.75	-0.46	-0.53	-0.18	0.95**	0.31	0.86**
Female, Minority	1.88	-1.13	-0.48	0.06	0.93**	0.52	0.93**
Observations	5,803	5,803	5,803	5,803	5,803	5,803	5,803
R-squared	0.074	0.069	0.052	0.034	0.025	0.025	0.037

Note: * p<0.10; ** p<0.05; *** p<0.01. Coefficients estimated using Ordinary Least Squares.

CHEMISTRY

- CTL endorsement program candidates earn scores that are not statistically different from scores earned by candidates in NJ or across the U.S.** The overall scaled scores of students from non-CTL programs in New Jersey or elsewhere in the U.S. are not significantly different from those of CTL students above the 0.10 confidence level. A few weak and significant differences exist between the scores of CTL students and those of non-CTL U.S. students, with non-CTL U.S. students having slightly lower scores on sections two and seven, but these differences are only significant at the 0.10 confidence level (Figure 2.3).
- Female students and students of minority races/ethnicities receive significantly lower scores on the Praxis chemistry exam across all three groups.** Not only did these groups receive lower overall scaled scores, but they also received lower scores for all seven sections of this exam. These differences are all highly significant at the 0.01 confidence level (Figure 2.3).

Figure 2.3: Linear Regression – Predicting Overall Scaled Score⁸ and Section Scores on Praxis Chemistry Exam

PREDICTOR	SCALED SCORE	SECTION 1	SECTION 2	SECTION 3	SECTION 4	SECTION 5	SECTION 6	SECTION 7
New Jersey	-0.96	-0.03	-0.61	-0.50	-0.09	-0.46	0.32	0.82*
United States	-2.82	-0.17	-0.70*	-0.94	-0.64	-0.84	0.52	0.89*
Female	-7.07***	-0.79***	-0.38***	-0.70***	-1.20***	-0.71***	-0.56***	-0.42***
Minority	-6.30***	-0.75***	-0.48***	-0.43***	-0.73***	-0.45***	-0.61***	-0.76***
Constant	168.01***	11.00***	8.48***	10.32***	15.14***	7.88***	7.87***	9.01***
Observations	10,416	10,416	10,416	10,416	10,416	10,416	10,416	10,416
R-squared	0.049	0.036	0.020	0.024	0.030	0.029	0.042	0.028

Note: * p<0.10; ** p<0.05; *** p<0.01. Coefficients estimated using Ordinary Least Squares.

⁸ If a student took the exam multiple times, the highest overall scaled score achieved is used in the analysis. All section scores also come from the attempt with the highest overall score. This is true for the both of the figures in this section.

SECTION III: MINORITY REPRESENTATION

The results presented in this section examine minority representation among CTL students, New Jersey students, and students from the rest of the U.S. on the Praxis chemistry and physics exams. The proportion of minorities in each of these groups is presented first followed by the respective p-values for direct comparisons between CTL students and students from New Jersey and the rest of the U.S. We conduct both Chi-square and Fisher's Exact tests of independence, and we present p-values for both tests.

- **Across both Praxis exams, a significantly larger proportion of CTL students are minorities compared to non-CTL students in New Jersey or the rest of the U.S.** Approximately 13 to 22 percent of non-CTL test-takers are minorities, while 37 to 40 percent of CTL test-takers are minorities (Figure 3.1 and Figure 3.2).
 - **These findings are strongest for the Praxis physics exam.** The 37.3 percent of minorities among CTL students who took the physics exam is statistically significantly different from the 19.8 percent of non-CTL New Jersey students who took the physics exam below the 0.01 confidence level in both the Chi-square and Fisher's Exact tests. By contrast, the same comparisons for the chemistry exams, while still statistically significant, are only significant at or above the 0.01 confidence level, likely due to the smaller number of CTL students who took the chemistry exams.
- **Differences between CTL students and students elsewhere in the U.S. are greater than those between CTL students and non-CTL students in New Jersey.** While the percentage of minorities from elsewhere in the U.S. who took these exams ranges from 13.4 to 16.3 percent, for non-CTL students in New Jersey the percentage ranges from 19.8 to 22.0 percent, somewhat closer to CTL's 37.3 to 40 percent. In addition, all differences in the proportion of minorities between CTL students and students elsewhere in the U.S. are significant at the 0.01 confidence level (Figure 3.1 and Figure 3.2).

Figure 3.1: Proportion of Minorities among CTL, NJ, and U.S. Students, by Praxis Exam

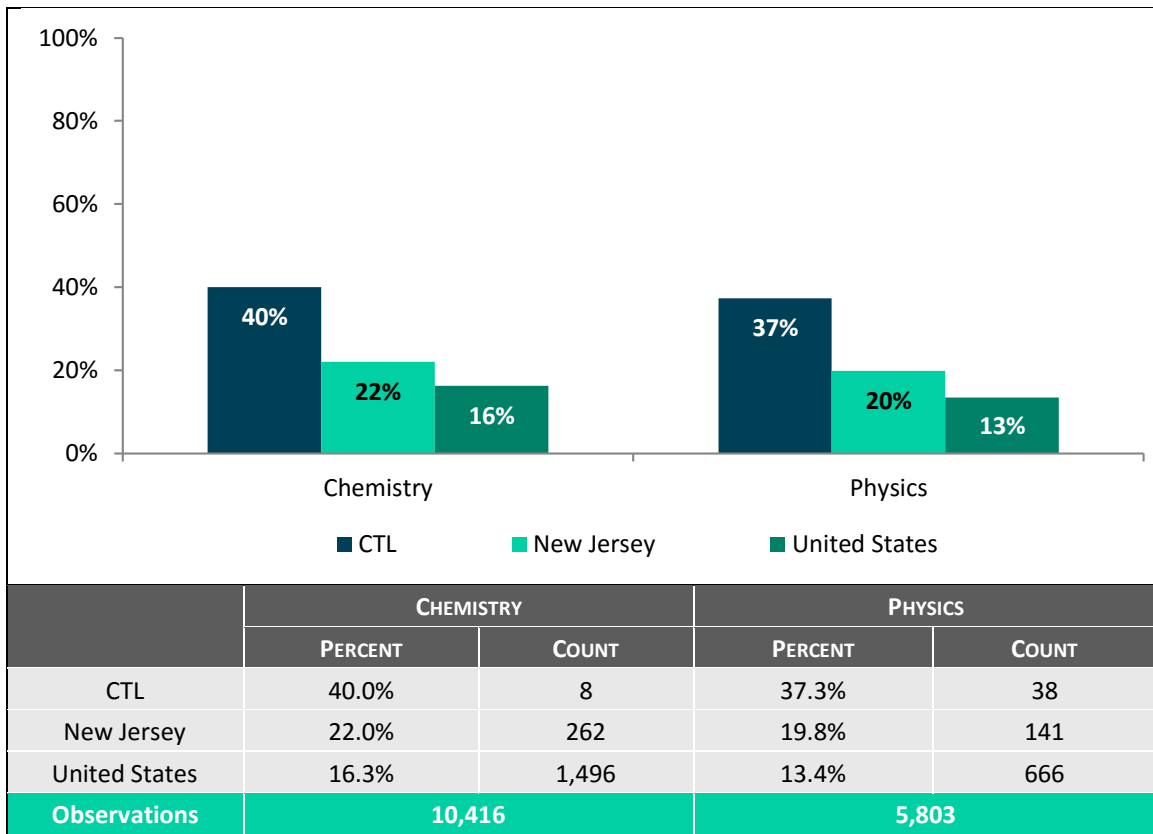


Figure 3.2: P-Values for Chi-Square and Fisher Exact Tests Comparing Minority Representation among NJ and U.S. Students versus CTL Students, by Praxis Exam

	CHEMISTRY		PHYSICS	
	χ^2	FISHER'S	χ^2	FISHER'S
New Jersey	0.055	0.098	0.000	0.000
United States	0.004	0.010	0.000	0.000
Observations	10,416		5,803	

Note: * p<0.10; ** p<0.05; *** p<0.01

SECTION IV: GENDER DIVERSITY

The results presented in this section examine gender diversity among CTL students, New Jersey students, and students from the rest of the U.S. on the Praxis chemistry and physics exams. The proportion of female students in each of these groups is presented first followed by the respective p-values for direct comparisons between CTL students and students from New Jersey and the rest of the U.S. We conduct both Chi-square and Fisher’s Exact tests of independence, and we present p-values for both tests.

- **The proportion of female CTL students who took the Praxis chemistry exam is somewhat smaller than the proportion among New Jersey and other U.S. students who participated in the exam.** However, due to the small sample size, the differences are not significant (Figure 4.1 and Figure 4.1).
- **A significantly larger proportion of CTL students who took the Praxis physics exam are female.** Among those who took the Praxis physics exam, 34 and 38 percent of non-CTL New Jersey and U.S. students, respectively, are female, while nearly half of CTL students are female (48 percent). These differences are significant at the 0.01 to 0.05 confidence level (Figure 4.1 and Figure 4.1).

Figure 4.1: Proportion of Women among CTL, NJ, and U.S. Students, by Praxis Exam

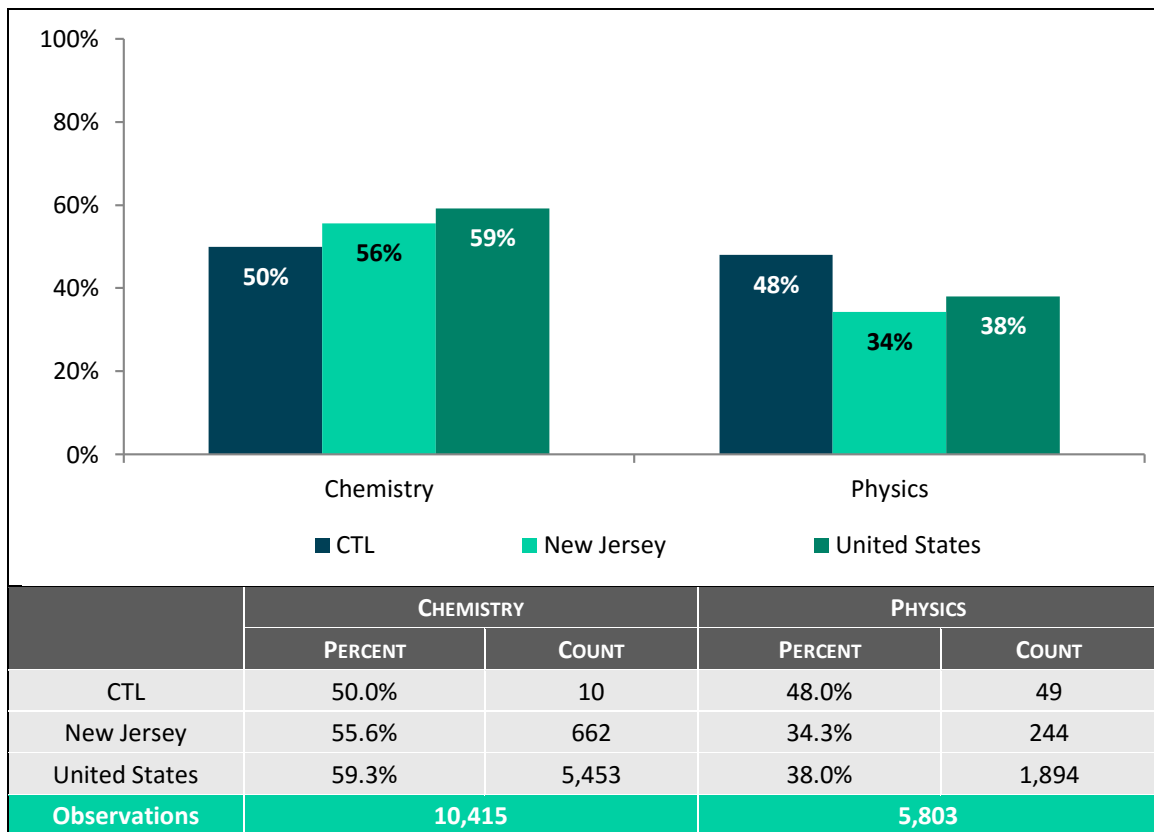


Figure 4.2: P-Values for Chi-Square and Fisher Exact Tests Comparing Female Representation among NJ and U.S. Students versus CTL Students, by Praxis Exam

	CHEMISTRY		PHYSICS	
	χ^2	FISHER'S	χ^2	FISHER'S
New Jersey	0.618	0.655	0.007	0.008
United States	0.401	0.495	0.038	0.040
Observations	10,415		5,803	

Note: * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$

PROJECT EVALUATION FORM

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4401 Wilson Boulevard, Suite 400

Arlington, VA 22203

P 202.559.0500 F 866.808.6585

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