College Enrollment Benchmarks for the NAEP Grade 12 Mathematics Assessment

AIR - NAEP Working Paper 2021-04

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Executive Summary

Ensuring that students are ready for college when they graduate from high school has important implications for students, educators, education policymakers, and other stakeholders. Thus, the research literature has identified several indicators for college preparedness, including school attendance, GPA, test scores, and college entrance exams. This study focuses on an examination of the relationship between the National Assessment of Educational Progress (NAEP) grade 12 mathematics assessment and college entry to identify benchmarks on the NAEP grade 12 Mathematics Assessment that are indicative of the skills prerequisite for college enrollment.

NAEP has been the gold standard for assessing what the nation's students know and can do at grades 4, 8, and 12 in reading, mathematics, and science as well as other subject areas. At each grade level and for each subject, cut points on the NAEP scale have been established to indicate whether performance is at the *NAEP Advanced*, *NAEP Proficient*, or *NAEP Basic* level or whether it is below the *NAEP Basic* level. Thus, it is logical to suppose that grade 12 NAEP performance should be indicative of whether students are prepared for college. In fact, studies commissioned by the National Assessment Governing Board (NAGB) indicate that NAEP can be used to predict college preparedness (Fields, 2014). However, one of the key studies used data from only one state, Florida, to establish an indicator of college preparedness: a score of 163 on the grade 12 NAEP mathematics assessment. A recent study by Ogut, Bohrnstedt, & Broer (2019), using a subsample of students from the High School Longitudinal Study of 2009 (HSLS:09) base-year collection who also took the 2013 NAEP grade 12 Mathematics Assessment (i.e., "the 2013 NAEP overlap sample"), showed that college admission benchmarks can be established on the NAEP assessment.

The purpose of the current study is to extend the analyses from the prediction of college admission to actual college enrollment as well as to additional indicators, such as persistence in college and the selectivity of the college attended. Using data from HSLS:09 and the 2013 NAEP overlap sample, this study examines the relationship between NAEP achievement and college enrollment as well as other college-related outcomes. The first set of analyses uses grade 12 NAEP mathematics achievement to model the probability of enrollment in postsecondary education with or without remediation, by the selectivity of the colleges enrolled in, by persistence in postsecondary education, and by majoring in a STEM field. The second set of analyses examines the ability of grade 12 NAEP mathematics achievement compared to achievement on the SAT mathematics college entrance exam to predict postsecondary outcomes (e.g., enrollment in a 4-year college), with and without controlling for high school GPA.

Key Findings

Overall, the results showed that NAEP mathematics achievement explained a considerable amount of the variation in postsecondary outcomes: about 28% in overall postsecondary enrollment and 34% in the selectivity of the colleges enrolled in. However, the variance explained decreased considerably in predicting enrollment without remediation, choosing a STEM major, and persistence: 23%, 17%, and 6%, respectively.

When translated into probabilities, the performance at the cut score for the *NAEP Basic* achievement level corresponded to a 33% probability of entry into a 4-year college: 12% into a 4-year that was neither classified nor inclusive, 16% into moderately selective one, and a 5% into a highly selective one. A student at the *NAEP Proficient* cut score had a 64% probability of entry into a 4-year college: 15% into a 4-year that was neither classified nor inclusive, 33% into moderately selective one, and 18% into highly selective one.

Performance at the *NAEP Basic* achievement level was also associated with a 49% probability of enrolling in postsecondary education without remedial coursetaking, a 13% probability of choosing a STEM major, and a 72% probability of persisting in college at least until February 2016 (the junior year in college for those who attended each year after high school). Performance at the *NAEP Proficient* level, instead, corresponded to a 77% probability of enrollment without remedial coursetaking, a 28% probability of choosing a STEM major, and an 84% probability of persistence at least until February 2016.

NAEP's college preparedness indicator was associated with a 53% probability of enrolling in a 4-year college: 15% a 4-year that was neither classified nor inclusive, 27% into moderately selective one, and 11% into a highly selective one. At the NAEP college preparedness indicator point, the probability of enrollment without remedial coursetaking was 68%; of choosing a STEM major, 21%; and of persisting in college at least until February 2016, 80%.

There were differences in the relationships between NAEP and the various outcomes by subgroup. Results showed that at a given NAEP achievement level, Black students had higher probabilities of postsecondary enrollment than White or Hispanic students. Both Black and White students had higher probabilities than Hispanic students of enrollment in more selective colleges, as well as higher probabilities of choosing STEM majors. White and Black students also had higher probabilities of postsecondary enrollment without remediation than did Hispanic students. The study also found that at each achievement level, female students had higher probabilities of postsecondary enrollment, enrolling in colleges with higher selectivity, enrolling without the need for remedial coursetaking, and persisting in college than male students. However, male students had higher probabilities than females of choosing STEM majors in 4-year colleges.

Compared with the SAT mathematics college admissions test, the NAEP grade 12 Mathematics Assessment was about equally good at predicting students' enrollment into postsecondary education, the selectivity of the colleges enrolled in, remedial coursetaking, choosing a STEM major, and persistence when controlling for overall high school GPA.

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Background

There is a growing consensus that earning a high school diploma is not enough to prepare students for college. Reports estimate that only about one-third of students in the nation are prepared for college when they graduate from high school (ACT, 2017). The rates are not much better for those students who show an interest in postsecondary education by taking a college admissions test. Among students who took the SAT in 2017, only 46% were found ready to take and succeed in entry-level, college credit-bearing courses.[1] Even when students are admitted to college, they often are not academically ready and they often take remedial coursework. In the 2010-11 school year, 29% of students in 4-year public colleges and 41% of students in 2-year colleges reported taking remedial courses (Skomsvold, 2014). According to transcript data from the Beginning Postsecondary Students (BPS) longitudinal study, remedial coursetaking rates among a cohort of students who entered college in the 2003-04 school year were 39% for those in public 4-year institutions and 68% for those in public 2-year institutions (Radford and Horn, 2012).

The concern over college preparedness has led to several policy initiatives. In 2009, the U.S. Department of Education announced the Race to the Top (RTT) grant to encourage and reward states for innovation in K-12 education. One of the conditions for funding was that states adopt college- and career-ready proficiency standards. In addition, one of the aims of the Common Core State Standards, which have been adopted by many states, is to ensure that all students graduate from high school ready to succeed in college and in their careers.

At the high school level, the most frequently noted college preparedness indicators are high school attendance, GPA, and college admission test scores. For example, missing no more than 10 percent of school days per grade level has been shown to be associated with being on-track for high school graduation (Allensworth and Easton, 2007). Maintaining a GPA of 3.0 or higher, or passing a high school exit exam or college entrance exam, has also been shown to be correlated with college entrance and successfully completing credit-bearing, entry-level college courses (Mishook et al., 2012). However, these indicators are of limited utility because they are not collected by all states. Similarly, the SAT and ACT tests, which are indicative of future performance in college, are taken by only a select number of students. Because of these limitations, it would be beneficial to both policymakers and the public to have benchmarks signifying college preparedness derived from a test with a common metric that could be used by all states. Such a test is the National Assessment of Educational Progress (NAEP).

NAEP has long been viewed as the “gold standard” for assessing what students know and can do in grades 4, 8, and 12. Going back to 1990, students across the country have been regularly

[1] See https://reports.collegeboard.org/archive/sat-suite-program-results/2017/class-2017-results.

assessed in NAEP in key subjects such as reading, mathematics, science, and writing. Furthermore, all states are required to participate in the NAEP reading and mathematics assessments at grades 4 and 8 if they are to receive Title 1 funds from the federal government.

Thus, the grade 12 NAEP assessment would seem to be the perfect candidate on which to establish college preparedness benchmarks. In fact, for over a decade the National Assessment Governing Board (NAGB) has used it to carry out a series of such studies. One study, which used longitudinal data from the state of Florida, arrived at a NAEP preparedness benchmark on the grade 12 NAEP mathematics assessment and showed that NAEP could be used to predict acceptable end-of-first-year college performance, where acceptable performance was defined as a 2.67 (B-) or better grade point average. However, the study was limited in that the data came from just a single state, and students who attended out-of-state colleges or non-public colleges in Florida could not be followed (Fields, 2014).

To alleviate the limitations of the NAGB Florida study, Ogut, Bohrnstedt, and Broer (2019) used data for a subsample of students from the High School Longitudinal Study of 2009 (HSLS:09) who had also been selected to participate in the grade 12 NAEP 2013 mathematics assessment. (Note that HSLS:09 constitutes a nationally representative sample of 9th-graders in 2009.) The study showed that grade 12 NAEP achievement can be used to predict students' preparedness for college admissions and establish college admission benchmarks. However, the data only permitted an examination of the relationship of grade 12 NAEP mathematics to college admission and enrollment *plans* because actual enrollment data was not yet available.

The purpose of the current study is to extend the work on college preparedness benchmarks for the NAEP grade 12 Mathematics Assessment to college enrollment and other indicators, using data from HSLS:09's second follow-up in 2016, 3 years after on-time graduation from high school. The second follow-up collected data from students on their postsecondary enrollment, major chosen, and persistence[2] in college. This study uses these data to examine the relationship between grade 12 NAEP mathematics scores and college enrollment, postsecondary persistence, and the need to take remedial courses. The data also allow for the identification of benchmarks on NAEP for different subgroups associated with different probabilities of college enrollment.

Research Questions

The current study examined the following research questions:

Research Question 1: What is the relationship between performance on the NAEP Grade 12 Mathematics Assessment and enrollment in postsecondary education, enrollment without

[2] Persistence is a composite variable created by HSLS:09 that shows the enrollment status of a student in February 2016, which corresponds to the second semester of the junior year for those students who enrolled in college immediately after high school.

remedial coursetaking, enrollment in colleges with different degrees of selectivity, choosing a STEM major in 4-year colleges, and persistence in postsecondary education?

- Does this relationship vary by gender, race/ethnicity, and SES?
- What are the probabilities of students who score at the *NAEP Basic*, *NAEP Proficient*, and *NAEP Advanced* levels on the grade 12 mathematics assessment enrolling in postsecondary education, enrolling without remedial coursetaking, enrolling in colleges with different degrees of selectivity, choosing a STEM major, and persistence in postsecondary education?

Research Question 2: How does the NAEP Grade 12 Mathematics Assessment compare to the SAT mathematics test in predicting entry into postsecondary education, entry into postsecondary education without remedial coursetaking, choosing a STEM major in 4-year colleges, and persistence in postsecondary education?

Methods

Data

The study utilized two datasets: (a) the special overlap sample of about 3,470[3] students who participated in the HSLS:09 base-year collection and who took the 2013 grade 12 NAEP Mathematics Assessment; and (b) all HSLS:09 students for whom imputed NAEP scores could be computed (Ogut, Bohrnstedt & Broer, 2015).

The HSLS:09 base-year data collection took place in the 2009-10 school year, with a random sample of all fall-term U.S. 9th-graders. The first follow-up of HSLS:09 took place in the spring of 2012 when most sample members were in the spring semester of the 11th grade. As part of the study, students took algebra assessments in grades 9 and 11.

HSLS:09 also collected transcripts for all students who remained in the sample in 2013, which included ACT and/or SAT scores if they took either or both assessments. HSLS:09 used concordance tables to transform ACT scores into SAT units, although the current study focuses only on SAT math scale scores. In addition, from June 1 to January 31, 2014, all students (or their parents) who had participated in the baseline and first follow-up studies were surveyed in the 2013 HSLS:09 update to determine college enrollment plans. In the second follow-up data collection in 2016, 3 years after high school graduation, information was collected on students' postsecondary enrollment, remedial coursetaking, and persistence in college. Data from the

[3] All the numbers in this paper are rounded to the nearest 10, per Institute of Education Sciences (IES) disclosure review risk rules.

base year, the first follow-up, the 2013 update, the high school transcripts, and the second follow-up were used for this study.

Outcomes Studied

Five outcomes were studied:

- College enrollment right after high school (0 = not enrolled, 1 = enrolled in a 2-year college, 3 = enrolled in a 4-year college).
- College enrollment without remediation, as reported by the student[4] (0 = not enrolled, 1 = enrolled in less than a 2-year college, 2 = enrolled in a 2- or 4-year college with remediation, 3 = enrolled in a 2- or 4-year college without remediation).
- The selectivity of colleges as defined by the Integrated Postsecondary Education Data System (IPEDS), which included the following categories: 4-year highly selective, 4-year moderately selective, 4-year inclusive, 4-year not classified, and 2-year or less; the lowest category in the model was for students who were not enrolled.
- Whether the student chose a STEM major. Data on who chose a STEM major comes from students' reports of the major they most seriously considered when first entering postsecondary education. HSLS:09 classifies STEM majors using the U.S. Department of Education's SMART grant definition, which differs slightly from that used by the National Science Foundation.[5]
- Persistence in postsecondary education. "Persistence" is a composite variable created by HSLS:09 to measure the enrollment status of a student in February 2016, which corresponds to the second semester of the junior year for those students who enrolled in college right after high school.

Analysis

Twenty NAEP plausible value scale scores were imputed for students in the dataset as described in Ogut, Bohrnstedt, and Broer (2015). In addition to the variables used in that study,[6] SAT mathematics scores, GPA, college enrollment, remedial coursetaking, college

[4] In the student questionnaire, students were asked whether they had taken any remedial or developmental courses between the time they finished high school and February 2016.

[5] This study uses the HSLS:09 variable X4ENTMJST ("considering a major in a STEM field") to determine whether a student was considering a STEM major. Unlike the National Science Foundation's definition, the Department of Education's SMART grant definition does not include psychology or the social and behavioral sciences, such as political science and economics, among the STEM fields.

[6] The imputation model in Ogut, Bohrnstedt, and Broer (2015) included algebra scores at grades 9 and 11, race/ethnicity, sex, parental education, receipt of special education services, and whether the first language learned was English.

selectivity, and STEM major were included as predictors in the imputation model since they are not part of the NAEP population structure model and therefore not including them in the imputation model would have resulted in biased parameter estimates for those variables in subsequent analyses.

To examine the relationship between grade 12 NAEP mathematics achievement and postsecondary outcomes (Research question 1), ordered logistic regression was used where the outcomes increase consecutively as a latent variable, as modeled below:

$$y_i^* = \beta_1 x_i + \varepsilon_i$$

where y_i^* is the unobserved measure of postsecondary outcome and x_i is the grade 12 NAEP mathematics achievement score. Twenty plausible values created for this study were used as the grade 12 NAEP mathematics achievement scores. Each analysis was run 20 times, and the results were combined to get the average estimates and associated standard errors.

Similar models were used for all analyses and outcomes. For college enrollment, the outcome variable is a three-alternative model (0 = not enrolled; 1 = 2-year or less institution, 2 = 4-year institution)[7] that is defined as

$$y_i = j \text{ if } \alpha_{j-1} < y_i^* \leq \alpha_j, j = 0,1,2,3$$

where $\alpha_0 = -\infty$ and $\alpha_5 = \infty$, with the analytical model then taking the form:

$$Pr(y_i = j) = \frac{e^{\alpha_j - \beta_1 x_i + \varepsilon_i}}{\left(1 + e^{\alpha_j - \beta_1 x_i + \varepsilon_i}\right)} - \frac{e^{\alpha_{j-1} - \beta_1 x_i + \varepsilon_i}}{\left(1 + e^{\alpha_{j-1} - \beta_1 x_i + \varepsilon_i}\right)}$$

where x_i is grade 12 NAEP mathematics performance. For selectivity of colleges enrolled in and enrollment without remediation analyses, ordered logistic regression models were run. For binary outcomes (choosing a STEM major and persistence), the ordered logistic regression models are essentially a logistic regression model.

Results from regression models were used to compute the probabilities of, for example, college enrollment at different NAEP proficiency cut points as well as at the score of 163 on NAEP mathematics set by the National Assessment Governing Board as the criterion for being college ready. The Governing Board defines preparedness as "…qualify[ing] for placement into entry-level college credit courses that meet general education requirements, without the need for remedial coursework in mathematics or reading" (Fields, 2013; Fields, 2014). Hypothetical

[7] The sample size for those entering less than 2-year colleges is small, therefore 2-year colleges and less-than-2-year colleges were combined into a less-than 4-year college category.

benchmarks that correspond to a 50% probability of achieving various postsecondary outcomes (e.g., enrollment into 4-year colleges) were also established in grade 12 NAEP mathematics as part of the current study.

To compare the performance of NAEP and the SAT in predicting postsecondary outcomes (Research question 2), we obtained estimates from models with NAEP or the SAT as the only predictor—as well as from models including GPA and NAEP or the SAT—these models were similar to model 3 above. Model fit statistics (e.g., pseudo R^2 squared) were then used to compare the relative performance of NAEP and SAT in the prediction of the postsecondary outcomes.

Results

Imputing plausible values

As discussed in the Analysis section, the first step in examining the relationship between NAEP achievement and postsecondary outcomes was to impute NAEP scores for the full HSLS:09 population. Four models that corresponded to the different outcomes examined in the study were run (Table 1). The results show that the variance explained in the NAEP achievement score ranged from 84.7% to 87.5%.

Table 1. Modified maximum likelihood regression results

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	−6.766 (5.288)	−2.013 (5.031)***	−4.607 (5.620)***	−5.530 (6.497)***	−3.195 (6.187)***
Algebra 11	1.641 (0.122)***	1.823 (0.104)***	1.616 (0.124)***	1.699 (0.125)***	1.678 (0.137)***
Algebra 9	0.917 (0.086)***	1.091 (0.089)***	0.909 (0.088)***	0.840 (0.093)***	0.873 (0.093)***
Black	−10.639 (3.287)**	−13.066 (3.556)***	−10.290 (3.362)**	−9.764 (3.520)**	−8.062 (3.220)*
Hispanic	−4.359 (2.359)	−6.926 (2.350)**	−4.320 (2.380)	−4.838 (2.575)	−3.291 (2.674)
Asian	2.279 (3.058)	0.684 (2.960)	2.060 (3.059)	3.575 (2.704)	−1.322 (3.129)
Other race	−2.189 (2.871)	−4.413 (3.062)	−2.120 (2.921)	−3.668 (2.963)	−1.202 (2.661)
Male	7.403 (1.743)***	5.158 (1.651)**	7.439 (1.768)***	7.820 (1.884)***	4.457 (1.705)*

Variable	Model 1	Model 2	Model 3	Model 4	Model 5
Parent college graduate	0.329 (1.501)	1.172 (1.572)	0.128 (1.520)	0.970 (1.641)	0.315 (1.709)
Income higher than $55,000	0.920 (1.621)	0.794 (1.653)	0.922 (1.652)	0.993 (1.792)	0.798 (1.797)
Enrolled in 4-year college	5.256 (2.431)				
Enrolled in less than 4-year college	1.641 (2.609)				
Highly selective			7.512 (2.953)*		
Moderately selective			5.510 (2.682)*		
Inclusive			2.613 (3.268)		
Selectivity not classified 4-year			5.222 (3.347)		
Selectivity not classified 2-year			1.729 (2.627)		
Persistence				1.927 (2.130)	
STEM major					5.130 (2.017)*
GPA	8.372 (1.602)		8.173 (1.610)***	8.933 (1.862)***	8.749 (1.811)***
Remedial coursetaking		2.509 (0.775)**			
Pseudo R^2	0.863	0.847	0.867	0.866	0.875

***p < .001, **p < .01, *p < .05.

SOURCE: U.S. Department of Education, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), High School Longitudinal Study of 2009 (HSLS:09).

Since some of the outcomes were highly correlated (enrollment and selectivity of the colleges enrolled in) and some had different samples (e.g., persistence only applies to students who enrolled in postsecondary education), we ran different models for each outcome. Using the results from these models, five sets of plausible values were created, as described in Ogut, Bohrnstedt, and Broer (2015), and used in the analyses that follow. Plausible values created using results from model 1 are used in analyses of postsecondary enrollment; from model 2, in analyses of postsecondary enrollment (with or without remedial coursetaking); from model 3,

in analyses of selectivity of colleges enrolled in; from model 4, in analyses of persistence; and from model 5, in analyses of enrollment in STEM majors.

Descriptive Statistics for the Analytic Sample

Table 2 displays the characteristics of the analytic sample. White students accounted for the majority of the analytic sample (54%). Hispanic students accounted for 21%, and Black and Asian students made up 13% and 4% of the sample, respectively. Thirty-seven percent of the students had a parent who was a college graduate or had a more advanced degree, and 51% of the students came from families with annual incomes higher than $55,000. The average NAEP scale score for the analytic sample was 150.62, slightly lower than the average scale score for the nation in 2013 (153.46).

Table 2. Characteristics of the analytic sample

Variable	Mean	SD	Min	Max
White	0.54	0.50	0.00	1.00
Black	0.13	0.33	0.00	1.00
Hispanic	0.21	0.41	0.00	1.00
Asian	0.04	0.20	0.00	1.00
Other race	0.08	0.28	0.00	1.00
Male	0.50	0.50	0.00	1.00
Parent college graduate	0.37	0.48	0.00	1.00
Income higher than 55K	0.51	0.50	0.00	1.00
Algebra, grade 11	50.91	9.97	24.96	84.91
Algebra, grade 9	50.82	9.83	24.10	82.19
GPA	2.70	0.80	0.00	4.00
NAEP score (imputed)	150.62	31.29	65.43	254.12

NOTE: *N* = 14,000. A comparison of the analytic sample with the 2013 NAEP operational sample is shown in table A-1 in appendix A.
SOURCE: U.S. Department of Education, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09).

After finishing high school, 27% of the analytic sample had not enrolled in college (table 3). About 3% were enrolled in less than 2-year programs, 28% in 2-year programs, and 43% in

4-year colleges. Twelve percent were enrolled in highly selective colleges, 20% in moderately selective colleges, and about 11% in inclusive or not classified 4-year colleges. Seventeen percent of those who were enrolled in any postsecondary institution had chosen a STEM major. Among those enrolled in any postsecondary institution, 23% reported taking one or more remedial courses. By February 2016, 77% of those who enrolled in college after high school were still enrolled or had completed a degree.

Table 3. Postsecondary outcomes for the analytic sample

Variable	Mean	SD
Variable	Mean	SD
Not enrolled	0.27	0.44
Enrolled in less than 2-year college	0.03	0.16
Enrolled in 2-year college	0.28	0.45
Enrolled in 4-year college	0.43	0.49
Highly selective college	0.12	0.33
Moderately selective college	0.20	0.40
Inclusive college	0.06	0.23
Not classified college	0.05	0.22
Not classified 2-year college	0.28	0.45
Not classified less than 2-year	0.03	0.16
STEM major	0.23	0.42
Remedial coursetaking	0.23	0.42
Persistence	0.77	0.42

NOTE: *N* = 14,000 for all variables except STEM major (*N* = 10,700), remedial course taken (*N* = 10,000), and persistence (*N* = 10,800), which are limited to students enrolled in postsecondary education.
SOURCE: U.S. Department of Education, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09).

When broken down by race/ethnicity and gender, the results show some differences in enrollment patterns, major selection, and persistence (Table 4). White, Black, and Asian students were more likely to enroll in 4-year colleges, whereas Hispanic students were more likely to enroll in 2-year colleges. Male students, White students, and Asian students were more likely to have chosen a STEM major than were other subgroups. Black and Hispanic students took remedial courses more often than did White and Asian students. Finally, White, Asian, and female students were more likely to persist than were their counterparts.

Table 4. Postsecondary outcomes for the analytic sample, by race/ethnicity and gender

Group	Not Enrolled	Less than 2 year	2-year	4-year	STEM	Remedial	Persistence
White	0.24	0.02	0.25	0.49	0.18	0.18	0.81
Black	0.33	0.03	0.25	0.39	0.12	0.29	0.70
Hispanic	0.31	0.03	0.37	0.29	0.14	0.34	0.73
Asian	0.15	0.01	0.27	0.57	0.33	0.14	0.87
Other race	0.30	0.05	0.27	0.38	0.14	0.24	0.70
Female	0.22	0.03	0.28	0.47	0.12	0.23	0.79
Male	0.31	0.02	0.27	0.39	0.22	0.22	0.75

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09).

Predicting Enrollment in Postsecondary Education

The ordered logistic regression models (Equation number 3) described in the Analysis section were run to examine the relationship between NAEP achievement and three levels of postsecondary enrollment: not enrolled, enrolled in a 2-year or less college, and enrolled in a 4-year college. In addition to NAEP achievement, the models also use other demographic variables to test whether the relationships between grade 12 NAEP mathematics and postsecondary outcomes hold when they are included. Table 5 displays the results from these analyses. In model 1, NAEP achievement by itself explains 28% of the total variance in enrollment in postsecondary education. The addition of race/ethnicity, gender and GPA, algebra scores, and parental education and income across models 2 through 5 increases the variance explained to 42%. In model 5, significant results are observed for all variables in the model, except grade 9 algebra and the Asian indicator variable.

The cutoffs in the ordered logistic regression models represent the estimated cut points on the latent variable (y_i^* in model 1 in the Analysis section) used to differentiate a given level from the other levels. For example, in model 1, the probability that a student with a given NAEP score was *not* enrolled in college was computed as

$p(y = 0) = p(z < cutoff\ 1)$

where z represents the predicted value (0.036*NAEP score) and *cutoff* 1 is 4.164. In other words, if a student's predicted value is less than 4.164, then that student likely was *not* enrolled in college. The likelihood of not enrolling in college increases as the student's predicted value decreases. Similarly, if a student's predicted outcome is higher than 5.843, then that student was likely enrolled in a 4-year college. Since there are three outcomes in this ordered logistic

regression, each student will have the likelihood of each of these three outcomes adding up to 100% and will be more likely to have the outcome with the highest probability.

Table 5. Ordered logistic regression model results for predicting postsecondary enrollment

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
NAEP achievement	0.036 (0.001)***	0.039 (0.001)***	0.023 (0.002)***	0.017 (0.003)***	0.017 (0.003)***
GPA			1.294 (0.064)***	1.289 (0.064)***	1.254 (0.062)***
Algebra, grade 11				0.018 (0.006)**	0.015 (0.006)*
Algebra, grade 9				0.008 (0.006)	0.004 (0.005)
Black		0.747 (0.104)***	0.882 (0.107)***	0.841 (0.108)***	0.970 (0.111)***
Hispanic		−0.019 (0.079)	0.211 (0.078)**	0.189 (0.077)*	0.380 (0.078)***
Asian		−0.126 (0.199)	−0.031 (0.193)	−0.048 (0.193)	−0.022 (0.209)
Other race		−0.004 (0.093)	0.208 (0.097)*	0.194 (0.097)*	0.266 (0.099)**
Male			−0.236 (0.061)***	−0.209 (0.061)***	−0.235 (0.062)***
Parent college graduate					0.599 (0.058)***
Income higher than $55K					0.332 (0.068)***
Cutoff 1: No college	4.164 (0.157)***	4.605 (0.186)***	5.572 (0.191)***	5.962 (0.191)***	5.791 (0.192)***
Cutoff 2: 2 years or less	5.843 (0.175)***	6.306 (0.206)***	7.507 (0.209)***	7.902 (0.207)***	7.771 (0.208)***
Pseudo R^2	0.282	0.293	0.398	0.400	0.416
N	14,000	14,000	14,000	14,000	14,000

***p <. 001, **p < .01, *p < .05.

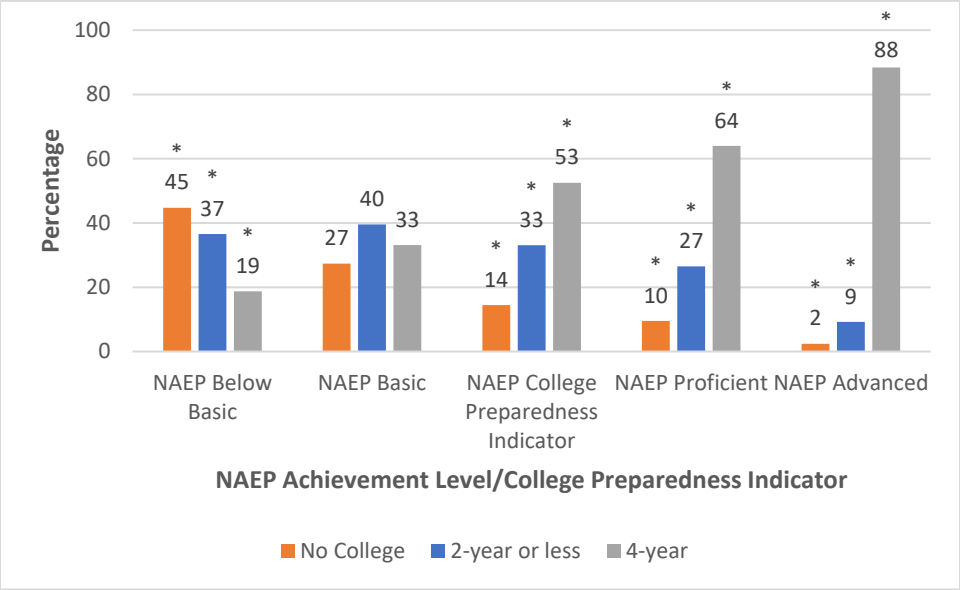
SOURCE: U.S. Department of Education, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09).

To examine the correspondence between NAEP achievement levels and postsecondary enrollment (as well as other outcomes, as reported later), cut-point scores for NAEP achievement levels and estimates from model 1 were used to compute the probabilities of postsecondary outcomes associated with NAEP achievement levels. Model 1 estimates the relationship between NAEP achievement and enrollment outcome without taking into account any student characteristics, ensuring that the probabilities computed are the same for all students and not adjusted for their demographic characteristics. Figure 1 shows the

probabilities of not enrolling, enrolling in a 2-year or less college, and enrolling in a 4-year college at the *NAEP Basic*, *NAEP Proficient,* and *NAEP Advanced* achievement cut scores. Since the Governing Board has not established a cut point for students performing below *NAEP Basic*, we computed the average NAEP achievement score for those students and used that to compute the corresponding probabilities. Therefore, that number represents the average probability of Below *NAEP Basic* students, whereas the numbers for *NAEP Basic*, *NAEP Proficient,* and *NAEP Advanced* represent the probabilities of students at the cut point (i.e., the minimal probability for the group).

Note that the probability of enrolling in a 4-year college increases from 33% at the *NAEP Basic* cut score to 64% at the *NAEP Proficient* cut score, reaching 88% at the *NAEP Advanced* level. The probability of enrolling in a 2-year or less college is 40% at the *NAEP Basic* level, dropping to 27% and 10% at the *NAEP Proficient* and *NAEP Advanced* levels, respectively. It is interesting to note that students who perform below *NAEP Basic* have a 19% probability of enrolling in a 4-year college and a 37% probability of enrolling in a 2-year or less college. What is less surprising is that the probability of not enrolling in a postsecondary education institution was highest for students who performed below *NAEP Basic* (45%) and only 2% for those at the *NAEP Advanced* level. Another way to look at the group of students who performed below *NAEP Basic* is that fully 56% attended either a 2- or 4-year college. The NAEP college preparedness indicator, on the other hand, was associated with a 33% probability of enrolling in a 2-year or less college and a 53% probability of enrolling in a 4-year college.

Figure 1. Probabilities of enrollment by NAEP achievement levels, and NAEP college preparedness indicator

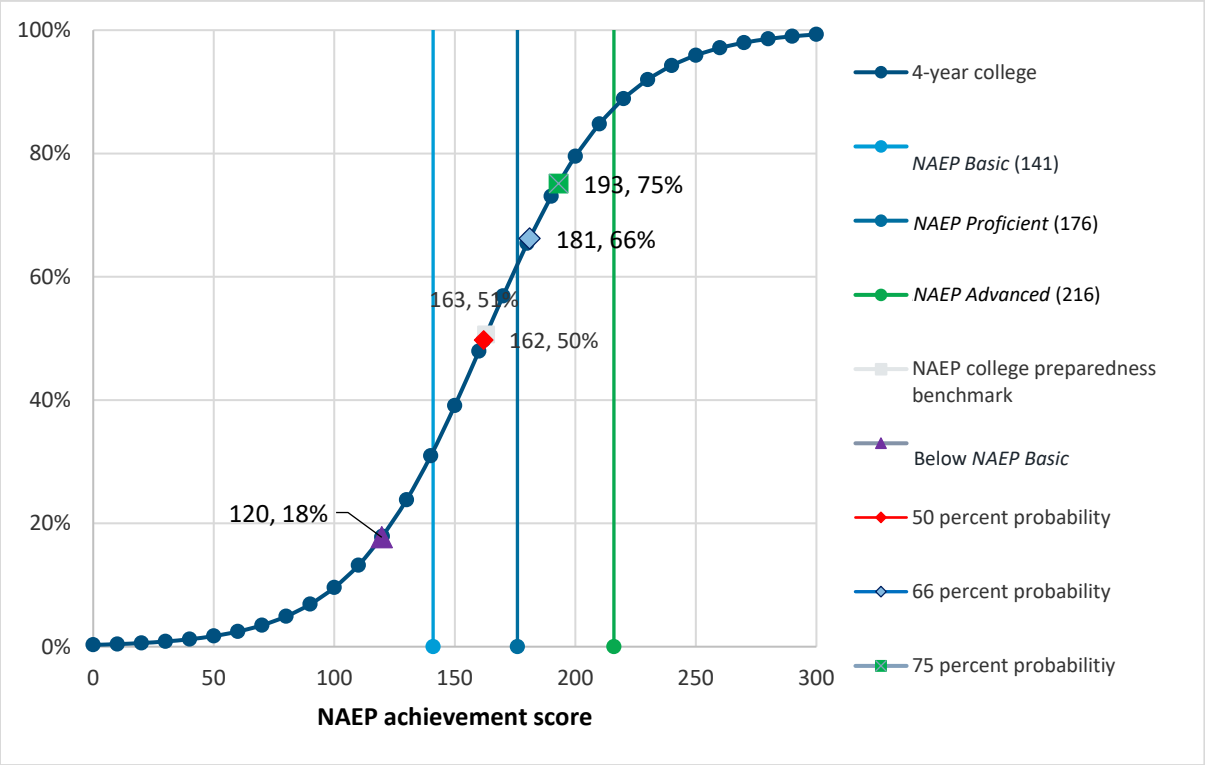


*Significantly different from the *NAEP Basic* achievement level.
SOURCE: U.S. Department of Education, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09).

It should be noted that these probabilities reflect not only the chances of admission but the decision to apply to a 4-year or 2-year college or not to apply at all. For example, for students at the *NAEP Advanced* level, the 88% probability of entering a 4-year college represents the fact that most high-performing students choose to apply to a 4-year college rather than to a 2-year college, as well as to their high rate of admission to 4-year colleges. In addition, since few advanced students choose to go to 2 year-colleges, the 9% probability of admission shown in figure 1 is mainly a function of the number of students who choose to go rather than of their admission chances. If one is interested, the probability of admission alone can be estimated; for example, the probability of admission for Advanced students to a 2-year college is estimated at 97% (see appendix A for more detail).

Figure 2 displays the probabilities of entering a 4-year college. It shows the same percentages as in figure 1 for the NAEP achievement levels as well as the probability of entering a 4-year college based on NAEP's college preparedness indicator (a score of 163 in mathematics). Notice that the indicator of 163 corresponds to a 51% probability of enrolling in a 4-year college. Hypothetical benchmarks that would yield probabilities of 50%, 66%, and 75% of entering a 4-year college correspond to scores of 162, 181, and 193, respectively, on the grade 12 NAEP mathematics scale.

Figure 2. Predicted relationship between NAEP achievement score and 4-year college enrollment



SOURCE: U.S. Department of Education, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09).

Enrollment without remediation

Remedial coursetaking information is reported by the student as part of the student background survey. To mimic NAEP's definition of college preparedness, the data were pooled across 4-year and 2-year college enrollment to create an ordered variable with four levels:

- 0: not enrolled;
- 1: enrolled in a less than 2-year college;
- 2: enrolled in a 2- or 4-year college with remedial coursetaking; and
- 3: enrolled in a 2- or 4-year college without remedial coursetaking.

The ordered logistic regression models (Equation number 3) described earlier were used to examine the relationship between NAEP achievement and enrollment in a postsecondary college without remediation. Table 6 displays the results from these analyses. In model 1, NAEP by itself explains about 10% of the total variance in enrollment without remediation. The addition of race/ethnicity, gender and GPA, algebra scores, and parental education and income

across models 2 through 5 increases the variance explained up to 13%. In model 5, even with the addition of parental socioeconomic status (SES) variables, the amount of variance explained remains at 13% but the estimate for NAEP achievement is no longer statistically significant. Instead, GPA and grade 9 algebra appear to explain most of the variance.

Table 6. Logistic regression model results for predicting enrollment without remediation

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
NAEP achievement	0.036 (0.001)***	0.038 (0.002)***	0.027 (0.002)***	0.028 (0.003)***	0.027 (0.003)***
GPA			1.137 (0.055)***	1.142 (0.058)***	1.106 (0.056)***
Algebra, grade 11				−0.003 (0.008)	−0.004 (0.008)
Algebra, grade 9				# (0.005)	−0.002 (0.005)
Black		0.583 (0.091)***	0.788 (0.103)***	0.796 (0.108)***	0.874 (0.109)***
Hispanic		0.057 (0.084)	0.332 (0.099)**	0.337 (0.102)**	0.458 (0.104)***
Asian		0.191 (0.175)	0.154 (0.171)	0.156 (0.170)	0.176 (0.169)
Other race		−0.014 (0.085)	0.174 (0.091)	0.178 (0.092)	0.227 (0.093)*
Male			−0.189 (0.068)**	−0.191 (0.069)**	−0.206 (0.071)**
Parent college graduate					0.361 (0.063)***
Income higher than $55K					0.261 (0.065)***
Cutoff 1: No college	4.147 (0.204)***	4.526 (0.218)***	5.817 (0.221)***	5.786 (0.221)***	5.659 (0.218)***
Cutoff 2: Less than 2-year	4.301 (0.213)***	4.681 (0.226)***	5.998 (0.229)***	5.967 (0.228)***	5.843 (0.225)***
Cutoff 3: 2- or 4-year with remediation	5.132 (0.216)***	5.520 (0.230)***	6.941 (0.236)***	6.911 (0.234)***	6.795 (0.232)***
Cutoff 4: 2-year or lower without remediation	4.147 (0.204)***	4.526 (0.218)***	5.817 (0.221)***	5.786 (0.221)***	5.659 (0.218)***
Pseudo R^2	0.234	0.239	0.341	0.342	0.350
N	14,640	14,640	14,000	14,000	14,000

#Rounds to zero.

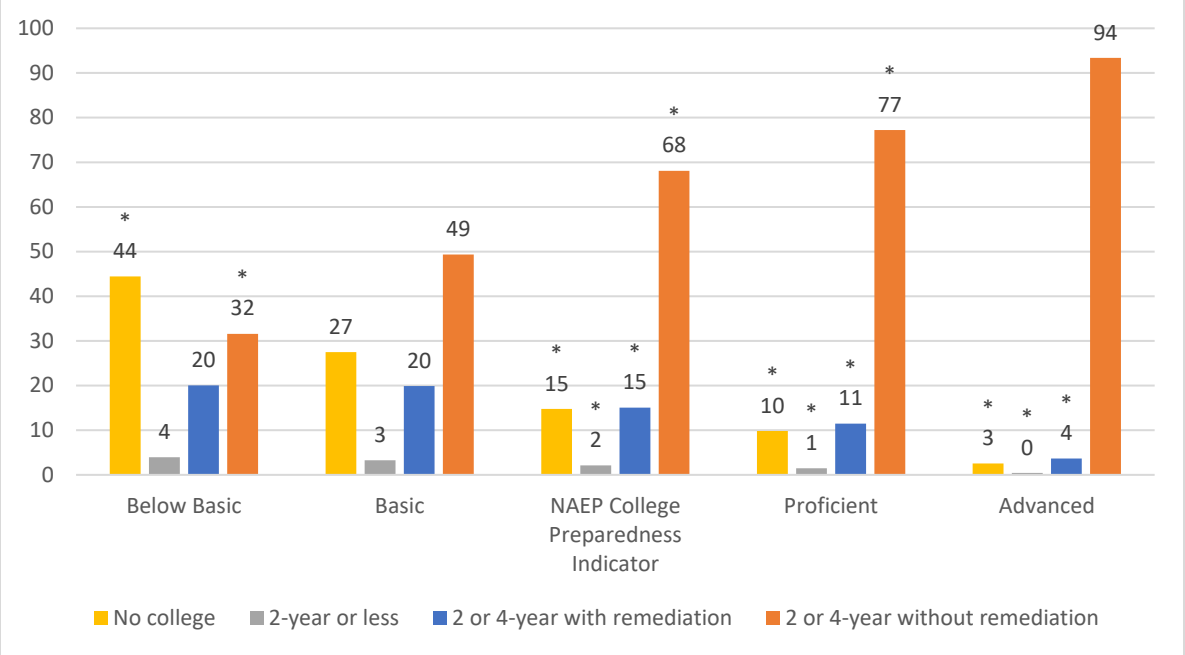
***$p < .001$, **$p < .01$, *$p < .05$.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09).

The results from model 1 were then used to estimate the predicted probabilities associated with the NAEP achievement levels and enrollment without remediation. The percentages shown in figure 3 show the probabilities of enrolling with or without remediation for the *NAEP Basic*, *NAEP Proficient,* and *NAEP Advanced* achievement levels and the NAEP college preparedness indicator. For students scoring below *NAEP Basic*'s cut score, their average achievement score was used to compute the corresponding percentages.

The results show that the probability of enrolling in a 2- or 4-year college without remediation increased from 49% at the *NAEP Basic* level to 94% at the *NAEP Advanced* level. Somewhat surprisingly, the average below *NAEP Basic* student had a 32 percent probability of enrolling without remediation. The probability for those at the NAEP college preparedness benchmark was 68%.

Figure 3. NAEP probability benchmarks for enrollment by remediation status in postsecondary education, by NAEP achievement level, and college preparedness indicator



#Rounds to zero.

*Significantly different from the *NAEP Basic* achievement level.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09).

Predicting the Selectivity of the College Enrolled in

The ordered logistic regression models (Equation number 3) described above were used to examine the relationship between grade 12 NAEP mathematics achievement and the selectivity of the postsecondary institution enrolled in. Selectivity was measured at six levels:

1. not enrolled;
2. selectivity not classified, 2-year college;
3. selectivity not classified, 4-year college;
4. inclusive 4-year college;
5. moderately selective 4-year college; and
6. highly selective 4-year college.

As in the earlier analyses, student and parent demographic variables are used as controls in the models. Table 7 displays the results from these analyses. In model 1, NAEP achievement by itself explains about 26% of the total variance in college selectivity. The addition of race/ethnicity, gender and GPA, algebra scores, and parental education, and family income increases the variance explained to 39%. In model 5, all of the variables are statistically significant, except grade 9 algebra, Asian, and other race.

Table 7. Ordered logistic regression model results for predicting selectivity of the college enrolled in

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
NAEP achievement	0.039 (0.001)***	0.040 (0.001)***	0.026 (0.001)***	0.016 (0.002)***	0.016 (0.002)***
GPA			1.326 (0.060)***	1.308 (0.059)***	1.272 (0.057)***
Algebra, grade 11				0.030 (0.005)***	0.026 (0.006)***
Algebra, grade 9				0.011 (0.005)*	0.007 (0.005)
Black		0.618 (0.094)***	0.762 (0.097)***	0.704 (0.096)***	0.845 (0.099)***
Hispanic		−0.067 (0.082)	0.167 (0.081)*	0.134 (0.078)	0.334 (0.077)***
Asian		0.055 (0.177)	0.182 (0.175)	0.148 (0.174)	0.188 (0.183)
Other race		−0.096 (0.084)	0.101 (0.086)	0.078 (0.086)	0.143 (0.089)
Male			−0.204 (0.053)***	−0.168 (0.053)**	−0.184 (0.053)***
Parent college graduate					0.638 (0.059)***
Income higher than $55K					0.333 (0.061)***
Cutoff 1: No college	4.475 (0.144)***	4.776 (0.172)***	5.923 (0.174)***	6.526 (0.180)***	6.350 (0.181)***
Cutoff 2: 2-year or lower	6.161 (0.161)***	6.479 (0.190)***	7.873 (0.191)***	8.484 (0.196)***	8.350 (0.196)***
Cutoff 3: Not classified or lower	6.446 (0.162)***	6.769 (0.191)***	8.201 (0.192)***	8.814 (0.197)***	8.689 (0.197)***
Cutoff 4: Inclusive or lower	6.789 (0.163)***	7.117 (0.192)***	8.591 (0.194)***	9.207 (0.196)***	9.094 (0.196)***
Cutoff 5: Moderate or lower	8.364 (0.171)***	8.705 (0.201)***	10.290 (0.207)***	10.925 (0.207)***	10.864 (0.208)***
Pseudo R^2	0.343	0.355	0.446	0.452	0.473
N	14,000	14,000	14,000	14,000	14,000

***$p < .001$, **$p < .01$, *$p < .05$.

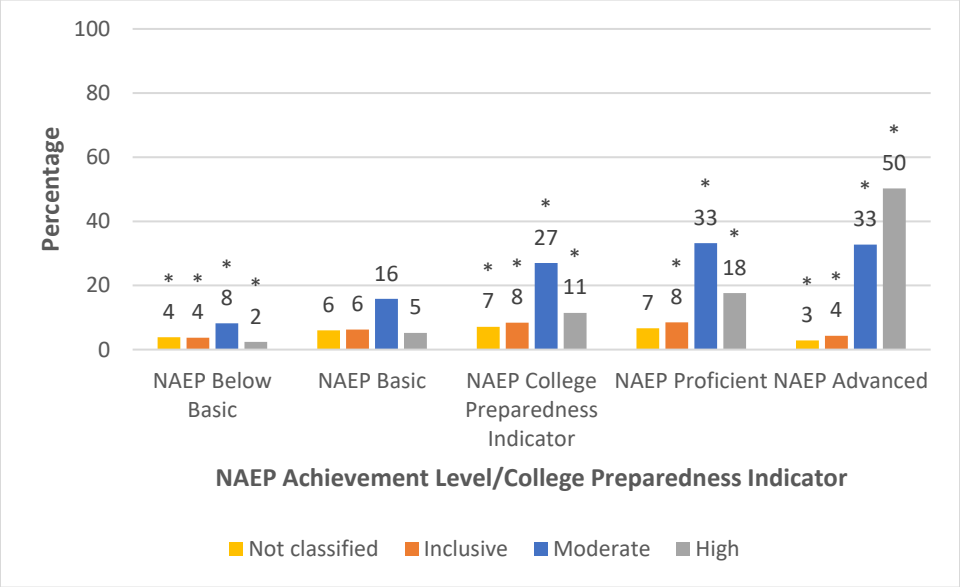
SOURCE: U.S. Department of Education, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09).

To determine the correspondence between the NAEP achievement levels and college selectivity, the results from model 1 were used to generate predicted enrollment probabilities.

In figure 4, the percentages show the probabilities of enrolling in colleges with different degrees of selectivity for the *NAEP Basic*, *NAEP Proficient,* and *NAEP Advanced* achievement levels and the NAEP college preparedness indicator. For students who fell below the *NAEP Basic* cut score, we again used their average achievement score to compute the corresponding percentages.

The results show that the probability of students enrolling in a highly selective college increased from 5% at the *NAEP Basic* level to 50% at the *NAEP Advanced* level, whereas their probability of enrolling in a moderately selective college was 33% at both the *NAEP Proficient* and *NAEP Advanced* levels. Students had a 6% probability of enrolling in an inclusive college at the *NAEP Basic* level and a 7% probability at the *NAEP Proficient* level. Interestingly, below *NAEP Basic* students had about a 10 percent probability of enrolling in a moderately or highly selective college. At NAEP's college preparedness indicator, the probabilities of enrolling in a 4-year inclusive college, a moderately selective college, or a highly selective college were 8%, 28%, and 12%, respectively. Although it is not shown in the figure, what is perhaps most surprising is that at the NAEP college preparedness cut point, the probability of either not attending college or attending no more than a 2-year college was fairly high, at 45% (not shown in the figure).

Figure 4. Probabilities of the selectivity of 4-year college enrolled in, by NAEP achievement level and NAEP college preparedness indicator



*Significantly different than the *NAEP Basic* achievement level.
SOURCE: U.S. Department of Education, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09).

Predicting Persistence in Postsecondary Education

Information on postsecondary persistence comes from an HSLS:09-derived variable that indicates whether a student who enrolled in postsecondary education after high school was still enrolled in or had attained a credential at any institution at the time of the second HSLS:09 data collection in February 2016. After the data were pooled across enrollment in 4-year and 2-year or less postsecondary institutions, logistic regression models were used to examine the relationships between NAEP achievement levels and persistence.

Table 8 displays the results from these analyses. In model 1, NAEP achievement by itself explains about 6% of the total variance in persistence. Although the addition of race/ethnicity, gender and GPA, algebra scores, and parental education and income in models 2 through 5 increases the variance explained to 12%, none of the estimates for race/ethnicity, gender, and algebra scores are statistically significant. In model 5, the estimate for NAEP achievement is statistically significant, along with GPA and parental education and income.

Table 8. Logistic regression model results for predicting persistence in postsecondary education

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
NAEP achievement	0.020 (0.002)***	0.019 (0.002)***	0.009 (0.002)***	0.010 (0.004)*	0.009 (0.004)*
GPA			0.883 (0.087)***	0.890 (0.084)***	0.855 (0.085)***
Algebra, grade 11				0.002 (0.011)	# (0.012)
Algebra, grade 9				−0.008 (0.007)	−0.011 (0.007)
Black		0.009 (0.175)	0.096 (0.172)	0.096 (0.183)	0.210 (0.176)
Hispanic		−0.079 (0.166)	0.081 (0.173)	0.080 (0.178)	0.242 (0.172)
Asian		0.226 (0.199)	0.332 (0.204)	0.338 (0.203)	0.379 (0.213)
Other race		−0.312 (0.140)*	−0.174 (0.148)	−0.172 (0.142)	−0.110 (0.151)
Male			−0.127 (0.078)	−0.132 (0.081)	−0.156 (0.081)
Parent college graduate					0.420 (0.085)***
Income higher than $55K					0.304 (0.082)***
Cut 1	1.840 (0.245)***	1.741 (0.261)***	2.608 (0.271)***	2.504 (0.289)***	2.371 (0.292)***
Pseudo R^2	0.064	0.066	0.11	0.11	0.119
N	10,800	10,800	10,800	10,800	10,800

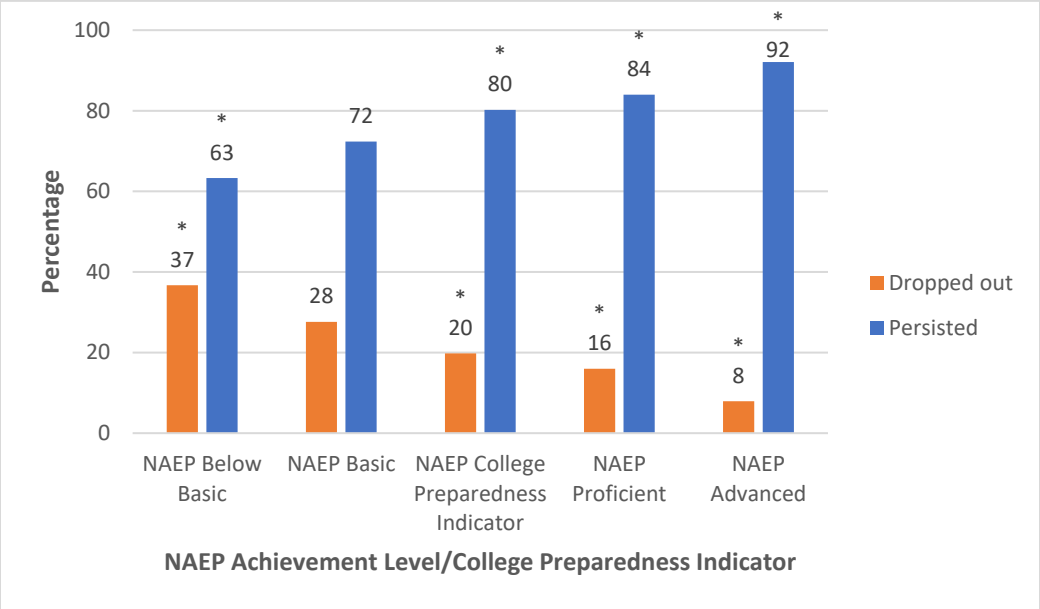
#Rounds to zero.

***$p < .001$, **$p < .01$, *$p < .05$.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09).

The results from model 1 were used to compute the predicted probabilities of postsecondary persistence associated with the NAEP achievement levels. The results in figure 5 show the probabilities of persistence increasing from 72% at the *NAEP Basic* level to 92% at the *NAEP Advanced* level. Not surprisingly, the probability of dropping out is highest for below *NAEP Basic* students. That noted, it is perhaps surprising that 63% of below *NAEP Basic* students who started college after high school had either completed or were still enrolled in college 3 years later. As expected, the probability of persistence for those scoring at NAEP's college preparedness benchmark lies between the probabilities associated with the *NAEP Basic* and *NAEP Proficient* levels, at 80%.

Figure 5. NAEP probability benchmarks for persistence in postsecondary education, by NAEP achievement level and NAEP college preparedness indicator



*Significantly different from the *NAEP Basic* achievement level.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09).

Predicting the Choice of a STEM major

The study also examined the relationship between NAEP achievement and enrolling in a STEM major, based on students' reports of the major they most seriously considered when entering postsecondary education. HSLS:09 classifies STEM majors using the U.S. Department of Education's SMART grant definition, which differs slightly from that used by the National Science Foundation.[8]

For this set of analyses, the sample was limited to those who entered 4-year colleges (see table 9). In model 1, NAEP achievement by itself explains about 17% of the total variance in choosing a STEM major. Moving from models 2 through 5, the addition of race/ethnicity, GPA and gender, algebra scores, and parental education and income increases the variance explained to 19.5%. In model 5, NAEP achievement and GPA remain statistically significant in the presence of these control variables.

[8] This study uses the HSLS:09 variable X4ENTMJST ("considering a major in a STEM field") to determine whether a student was considering a STEM major. Unlike the National Science Foundation's definition, the Department of Education's SMART grant definition does not include psychology or the social and behavioral sciences, such as political science and economics, among the STEM fields.

Table 9. Logistic regression model results for predicting the choice of a STEM major in postsecondary education

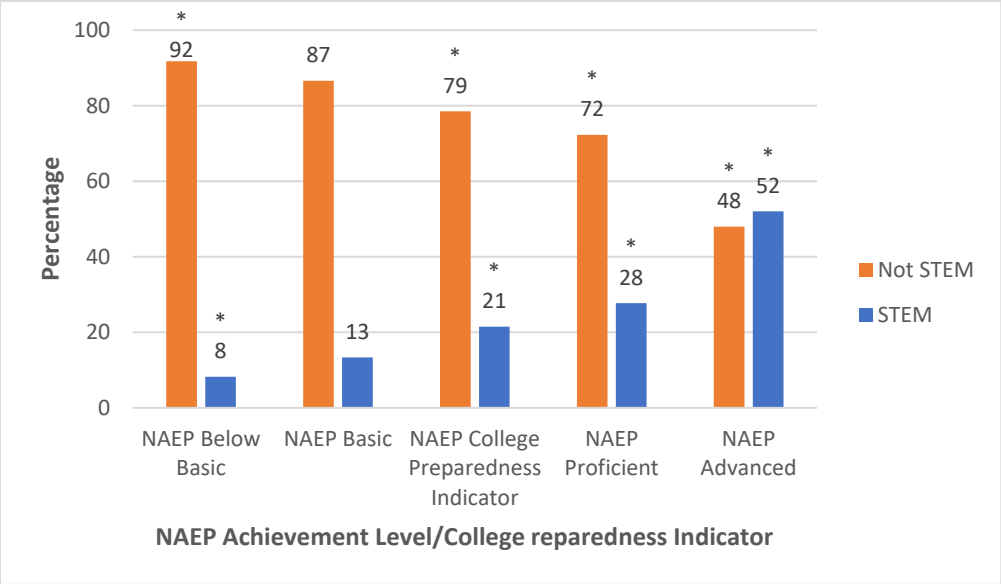
Variables	Model 1	Model 2	Model 3	Model 4	Model 5
NAEP achievement	0.038 (0.002)***	0.039 (0.002)***	0.029 (0.003)***	0.021 (0.004)***	0.021 (0.004)***
GPA			0.818 (0.089)***	0.759 (0.086)***	0.741 (0.086)***
Algebra, grade 11				0.023 (0.010)*	0.021 (0.010)*
Algebra, grade 9				0.012 (0.007)	0.012 (0.007)
Black		0.587 (0.179)**	0.728 (0.172)***	0.711 (0.171)***	0.744 (0.167)***
Hispanic		−0.044 (0.168)	0.115 (0.187)	0.094 (0.185)	0.149 (0.177)
Asian		0.431 (0.198)*	0.495 (0.192)*	0.424 (0.197)*	0.426 (0.195)*
Other race		0.135 (0.162)	0.256 (0.165)	0.248 (0.165)	0.257 (0.164)
Male			0.770 (0.090)***	0.769 (0.091)***	0.781 (0.089)***
Parent college graduate					0.212 (0.117)
Income higher than $55K					0.013 (0.106)
Cutoff 1: Not persisting in postsecondary	7.876 (0.305)***	8.142 (0.371)***	9.416 (0.389)***	9.899 (0.405)***	9.818 (0.418)***
Pseudo R^2	0.171	0.176	0.190	0.193	0.195
N	10,700	10,700	10,700	10,700	10,700

***$p < .001$, **$p < .01$, *$p < .05$.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09).

The results from model 1 were used to estimate the predicted probabilities of choosing a STEM major associated with the NAEP achievement levels. Figure 6 shows that the probabilities increase from 13% at the *NAEP Basic* level to 52% at the *NAEP Advanced* level. That is, over half of the students at the *NAEP Advanced* level are predicted to choose a STEM major, compared to 8% of the *NAEP Basic* students. Finally, the predicted probability that a student scoring at NAEP's college preparedness benchmark will choose a STEM major is 21%, or 7% lower than the probability associated with scoring at the *NAEP Proficient* level.

Figure 6. NAEP probability benchmarks for choosing a STEM major in 4-year colleges, by NAEP achievement level and NAEP college preparedness indicator



*Significantly different from the *NAEP Basic* achievement level.
SOURCE: U.S. Department of Education, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09).

Subgroup Analyses

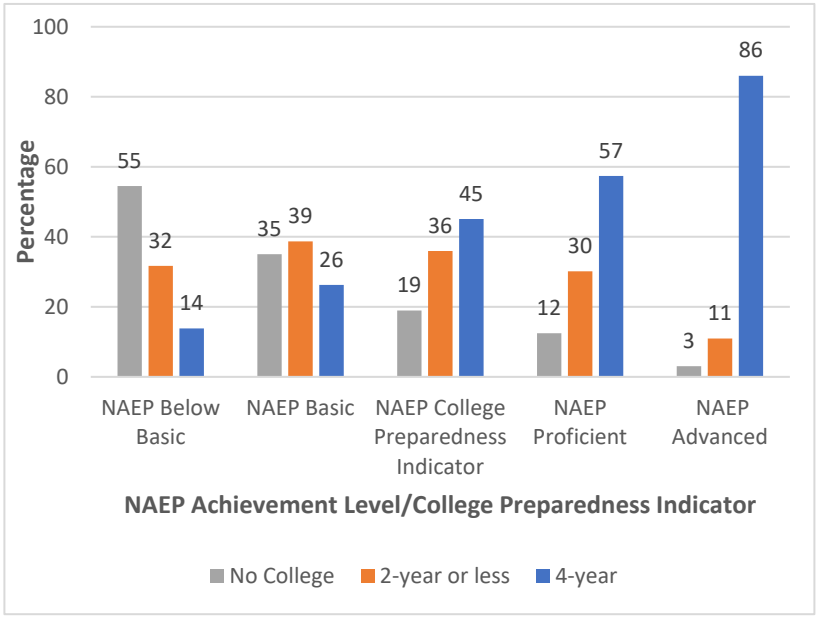
The previous results used data from all students to examine the relationship between NAEP achievement and postsecondary outcomes. The following set of results are subgroup analyses derived from the same models described previously but using only data from the population of interest. For example, in the case of racial/ethnic subgroups, model 3 was run separately for each racial/ethnic group reported. As before, the results from the subgroup analyses are grouped by the outcome of interest.

Predicting Enrollment in Postsecondary Education

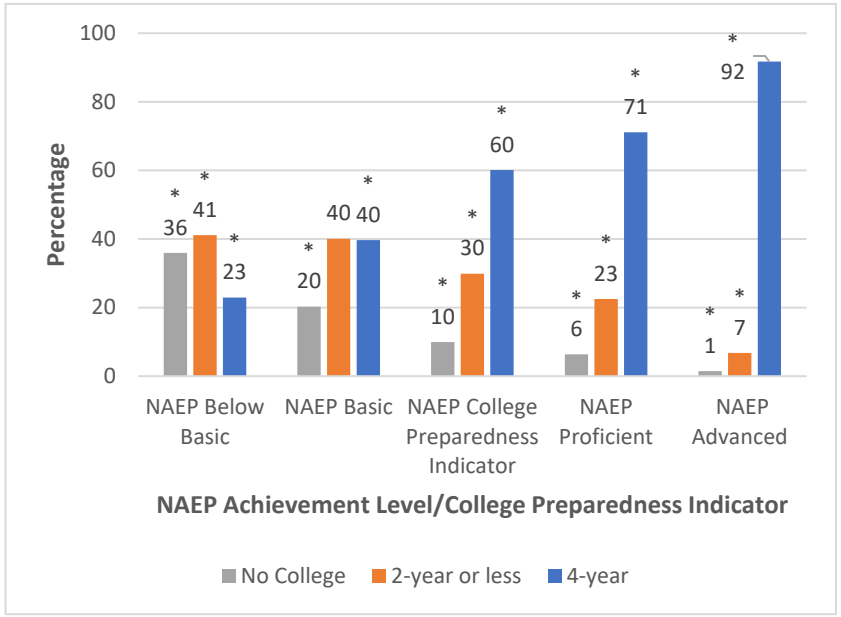
After estimating ordered logistic regression models where NAEP achievement is used to predict postsecondary enrollment, the results were used to compute a model to predict the probabilities of college enrollment by gender, race/ethnicity, and parental education. As shown in figure 7, there were some differences across student groups. Compared to male students, female students had higher probabilities of enrolling in 4-year colleges at every NAEP achievement level, including below *NAEP Basic*. Male students were also more likely not to enroll in any postsecondary education. Across racial/ethnic groups, at each achievement level, Black students had the highest probabilities of enrolling in 4-year colleges, followed by White students, then Hispanic students. At the *NAEP Basic* level, Hispanic students had a 50% chance

of enrolling in a 2-year college or less, compared with 34% for Black students and 37% for White students. At each achievement level, students whose parents graduated from college or had an advanced degree were more likely to enter 4-year colleges than were those students whose parents had less than a college education.

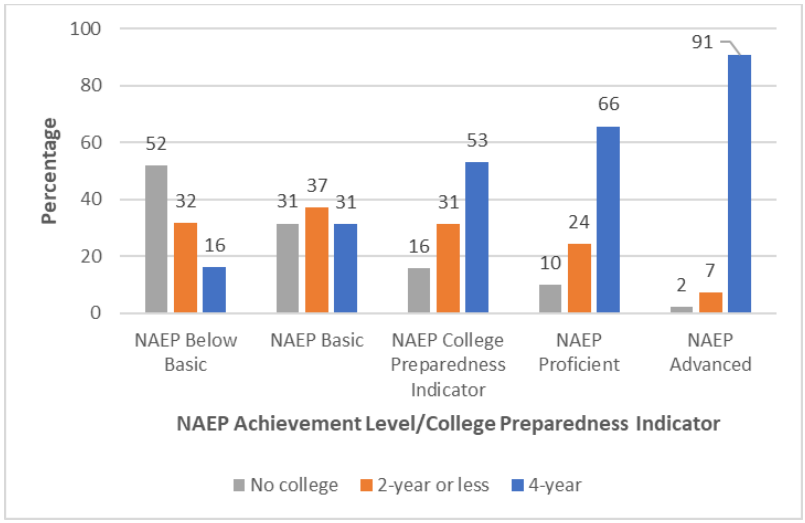
Figure 7. Probabilities of college enrollment, by NAEP achievement level, gender, race/ethnicity, and parental education



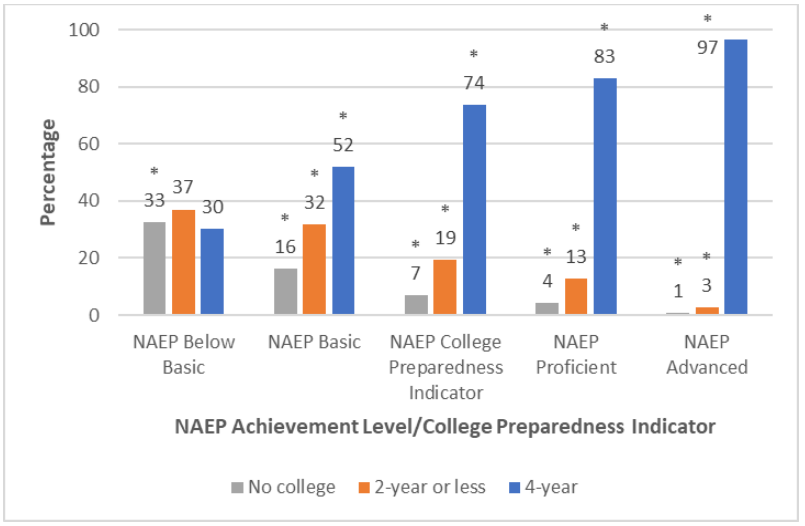
Male



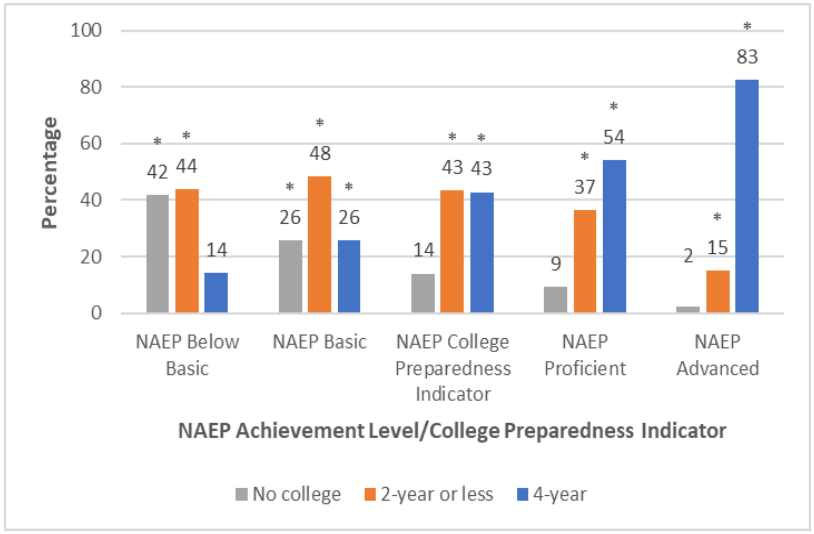
Female



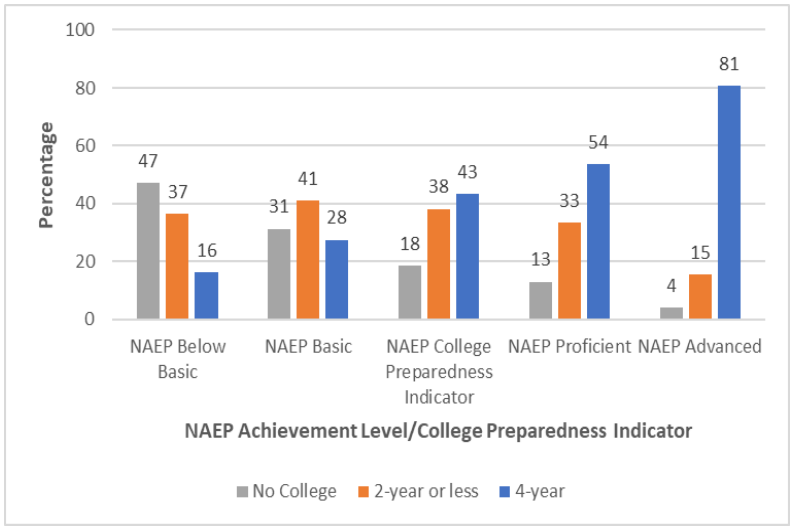
White



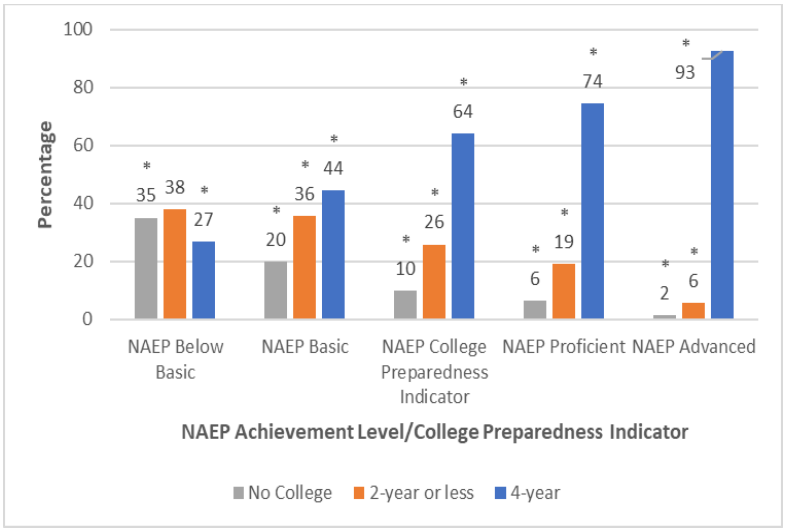
Black



Hispanic



Parental education less than college



Parental education college or higher

*Significantly different from the reference group (male, White, or parental education less than college).

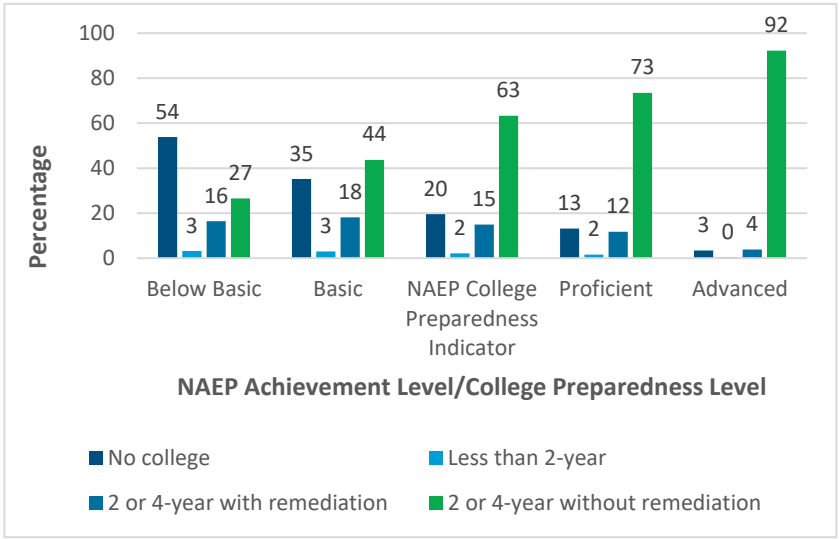
SOURCE: U.S. Department of Education, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09).

Predicting Enrollment without Remediation

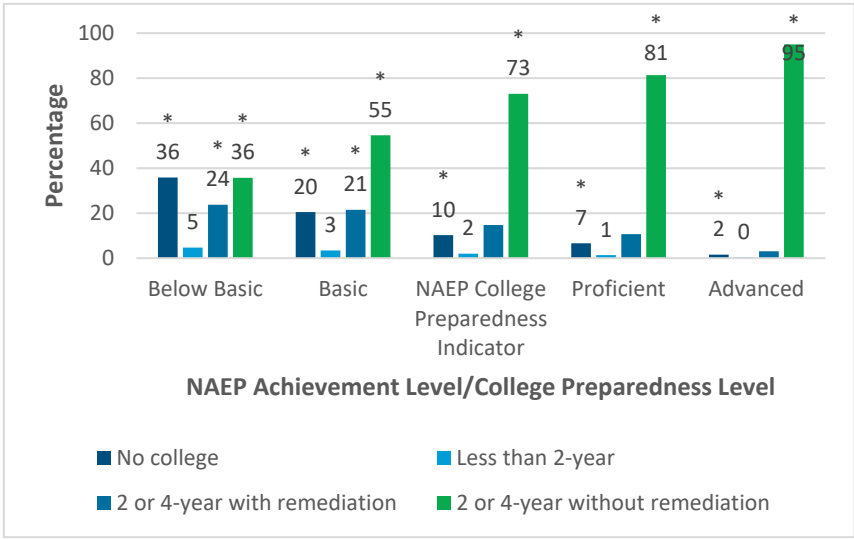
Figure 8 displays the probabilities of enrollment with or without remediation generated from separate ordered logistic regression models for the subgroups of interest. Across all subgroups, the probability of enrolling without remedial courses upon enrollment increased when moving from the *NAEP Basic* to the *NAEP Advanced* level. Similar to the results for overall enrollment, where female students higher probabilities of enrolling in 4-year colleges, they had higher probabilities of enrolling without remedial courses than did male students at each NAEP achievement level.

In addition to higher probabilities of enrolling in 4-year colleges, Black students had higher probabilities of enrolling without remedial coursetaking than did White students at all NAEP achievement levels, except Advanced. Hispanic students, on the other hand, had lower probabilities of enrolling without remedial coursetaking across most achievement levels. At each NAEP achievement level, students whose parents graduated from college or had an advanced degree had higher probabilities of enrolling without remedial coursetaking than did students whose parents had less than a college education.

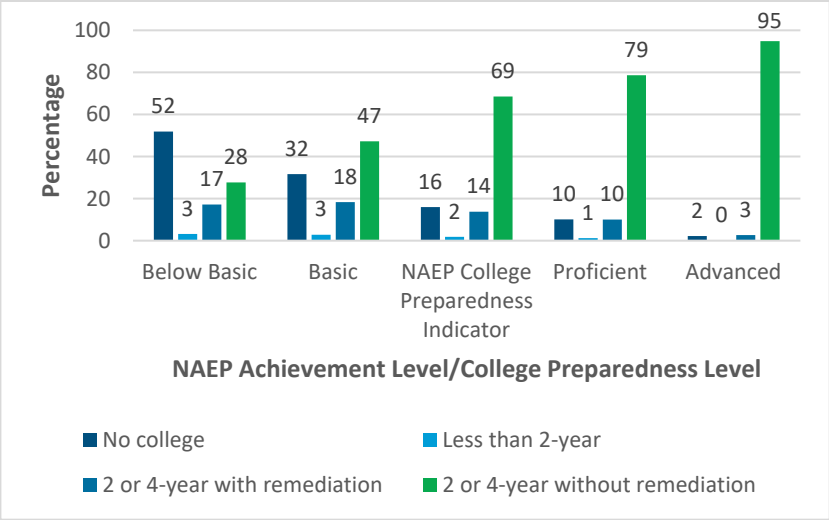
Figure 8. Probabilities of college enrollment without remediation, by NAEP achievement level, gender, race/ethnicity, and parental education



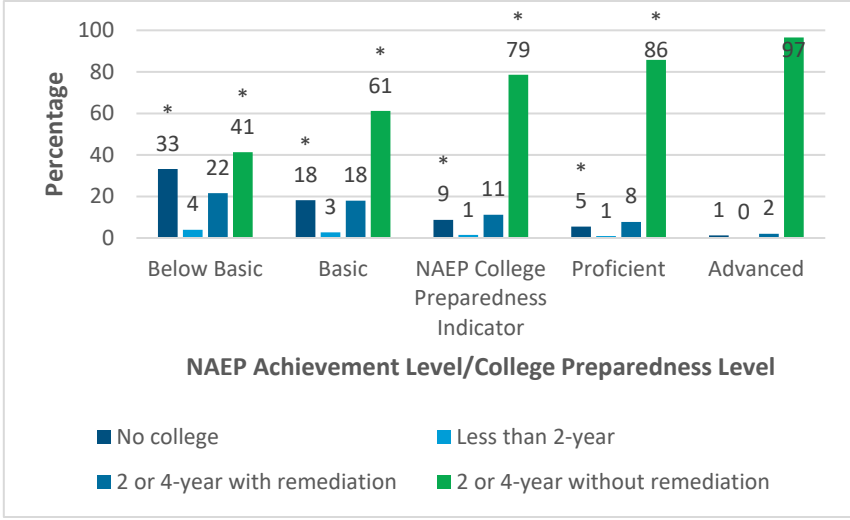
Male



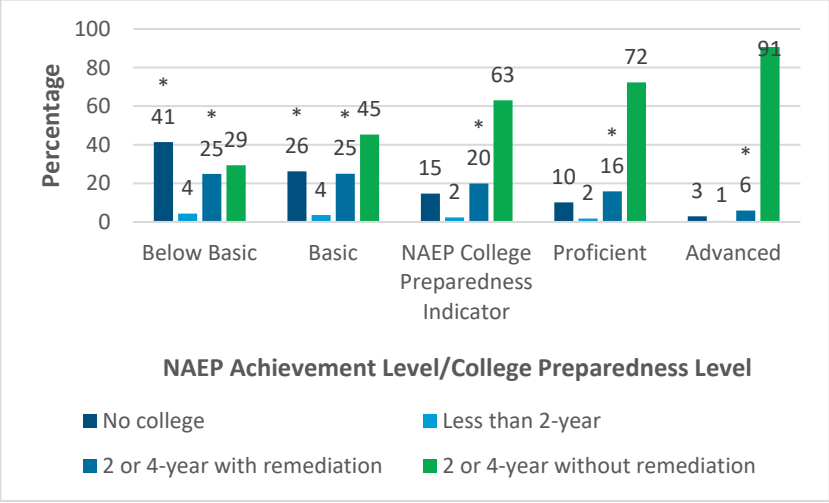
Female



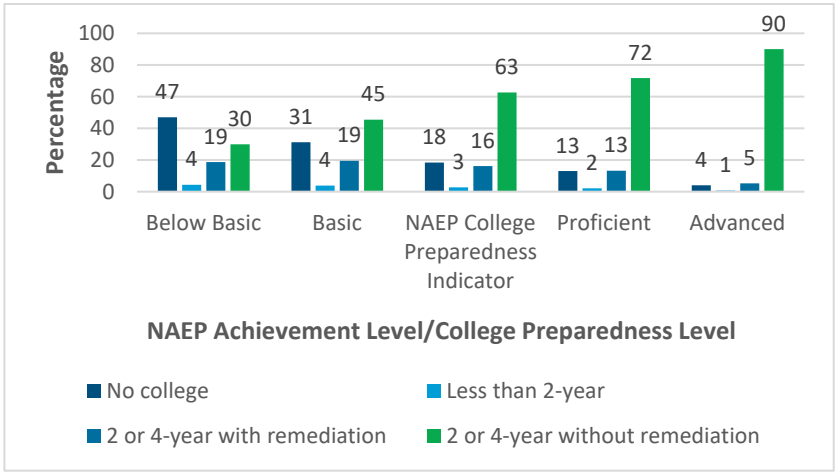
White



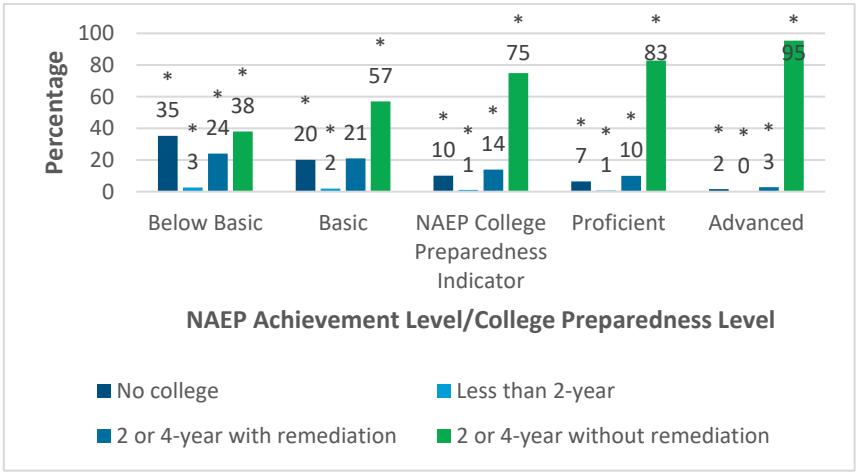
Black



Hispanic



Parental education less than college



Parental education college or higher

*Significantly different from the reference group (male, White, or parental education less than college).

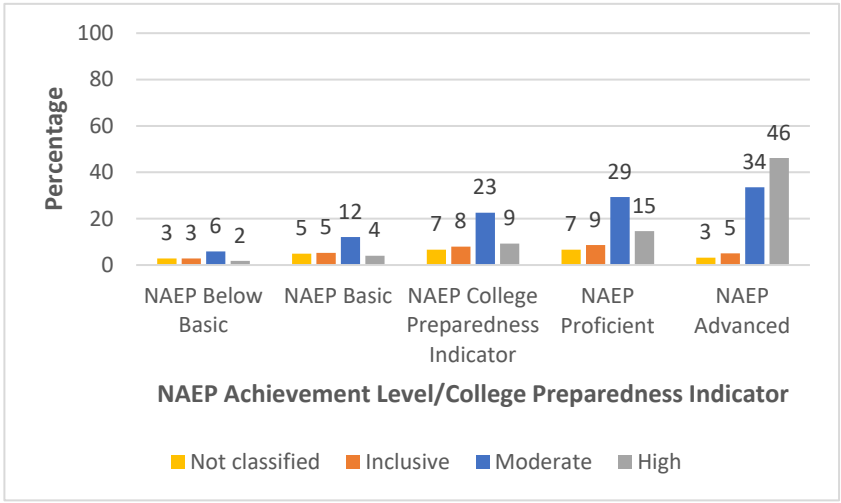
SOURCE: U.S. Department of Education, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09).

Predicting Selectivity of College Enrolled in

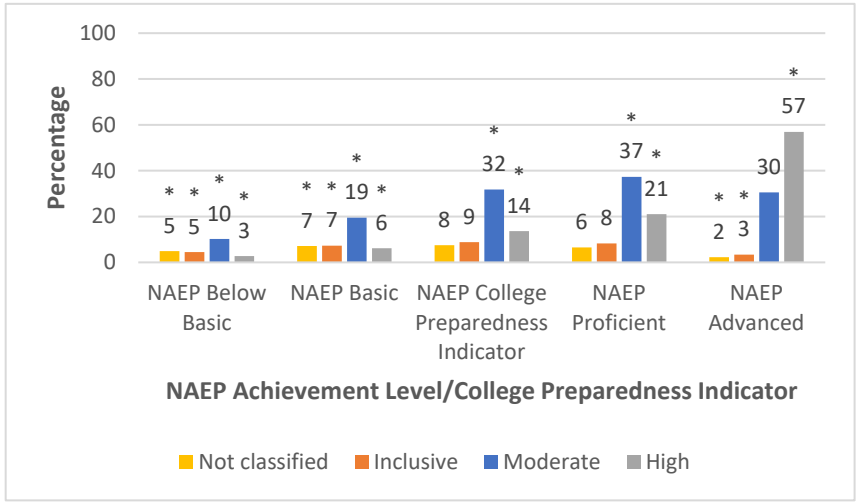
Figure 9 displays the probabilities of enrolling in colleges with different degrees of selectivity based on analyses from ordered logistic regression models for the subgroups of interest. The results are from models that included all degrees of selectivity, from not enrolled to highly selective colleges, although the figure displays the results only for 4-year colleges. First looking at differences by gender, female students had higher probabilities of enrolling in a highly selective college at each NAEP achievement level, which is consistent with the finding reported earlier for overall enrollment. At the *NAEP Proficient* level, female students also had a higher probability than male students of enrolling in a moderately selective college. In contrast, male students were equally likely to enroll in either a moderately selective college or a less than 4-year college.

Across racial/ethnic groups, Black students had a similar probability as White students of enrolling in highly selective colleges at each achievement level, whereas Hispanic students had a lower probability than both Black students and White students. Black students at the *NAEP Proficient* level had a 49% probability of enrolling in a moderately selective 4-year college, compared with a 34% probability for White students and a 27% probability for Hispanic students. Hispanic students at the *NAEP Proficient* level had a 37% probability of enrolling in a less-than 4-year college.

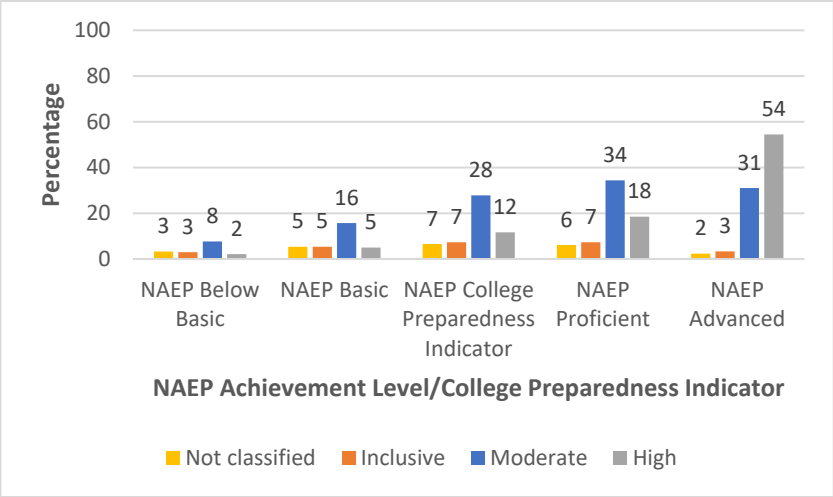
Figure 9. Probabilities of enrolling in 4-year colleges with different degrees of selectivity, by NAEP achievement level, gender, race/ethnicity, and parental education



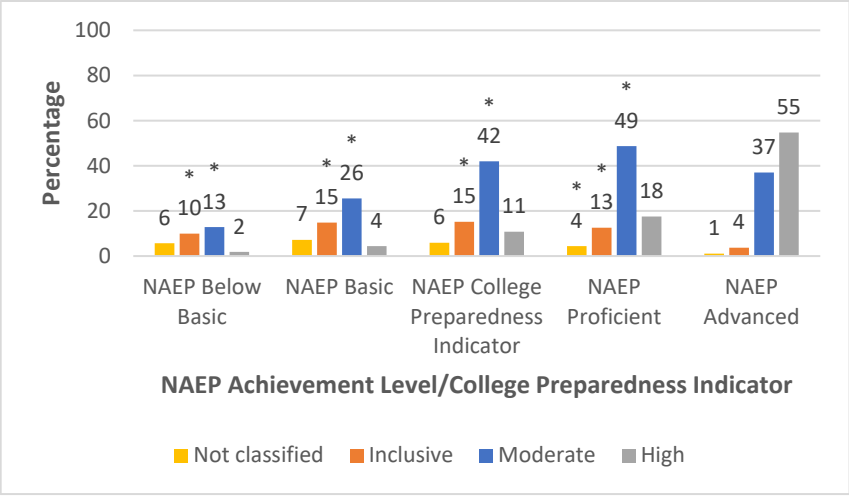
Male



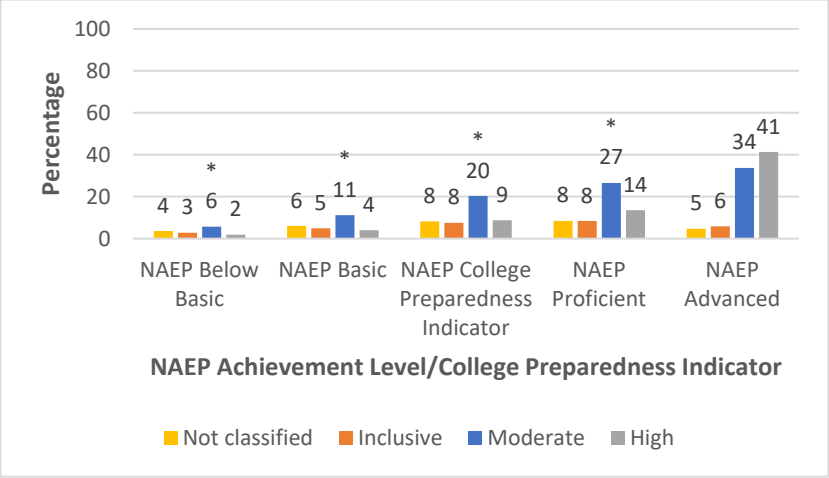
Female



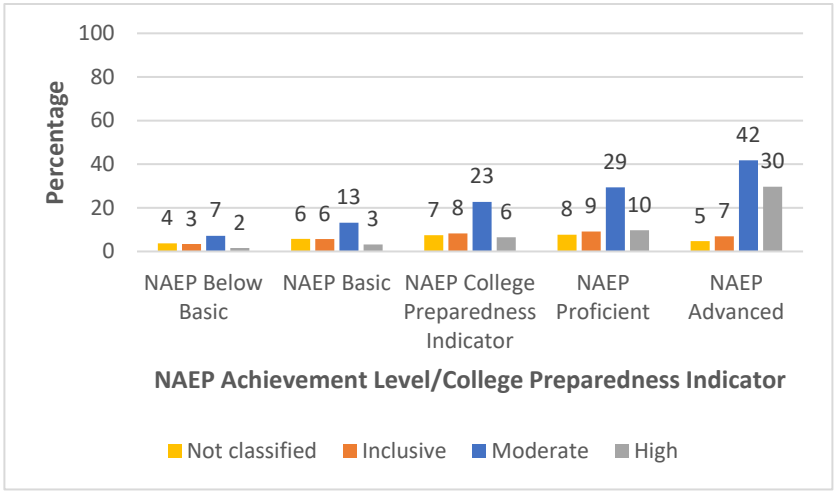
White



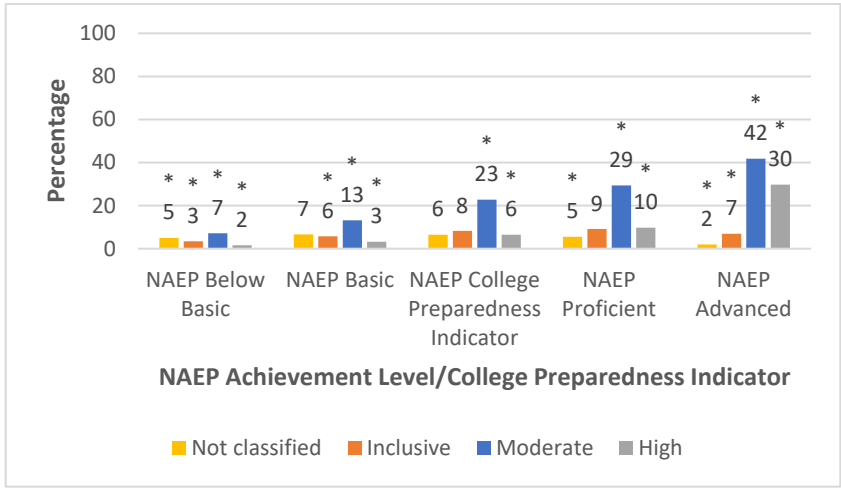
Black



Hispanic



Parental education less than college



Parental education college or higher

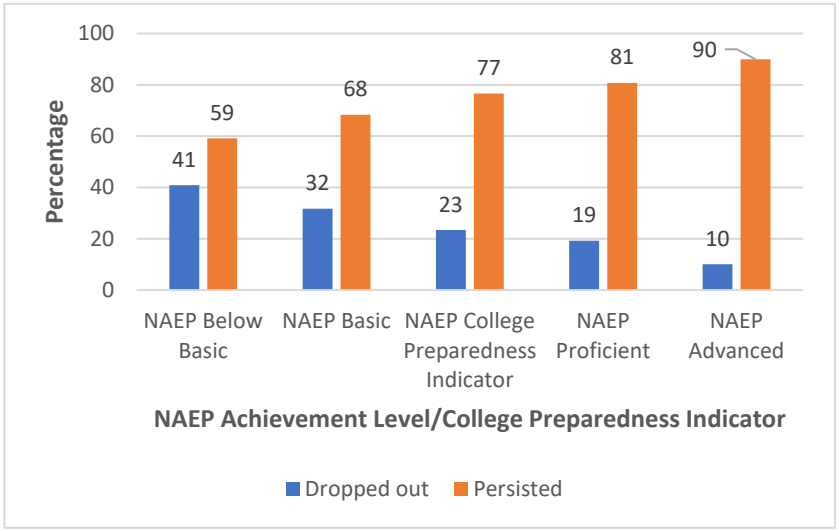
*Significantly different from the reference group (male, White, or parental education less than college).

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09).

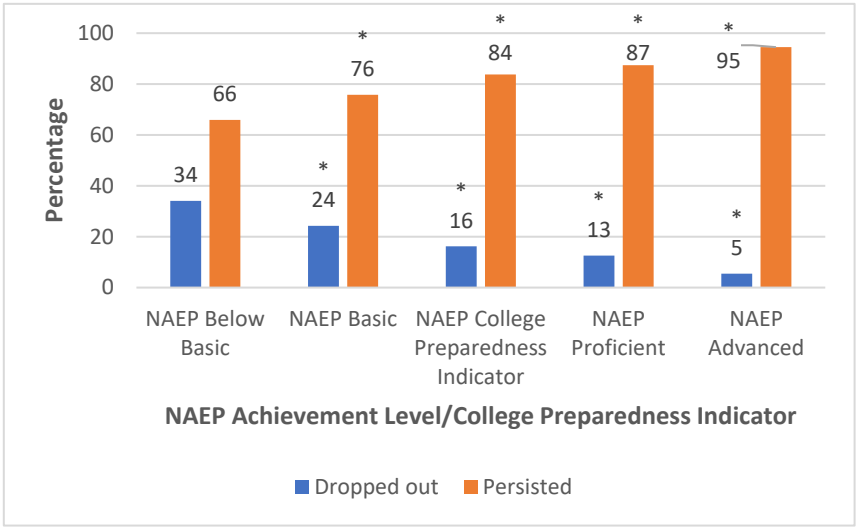
Predicting Persistence in Postsecondary Education

In terms of postsecondary persistence, female students had higher probabilities than male students of persisting in college at each NAEP achievement level, whereas Black students had lower probabilities than either White or Hispanic students, although the differences were not statistically significant (figure 10). At each NAEP achievement level, the probabilities of persistence were higher for students whose parents graduated from college or had advanced degrees than for students whose parents had less than a college education.

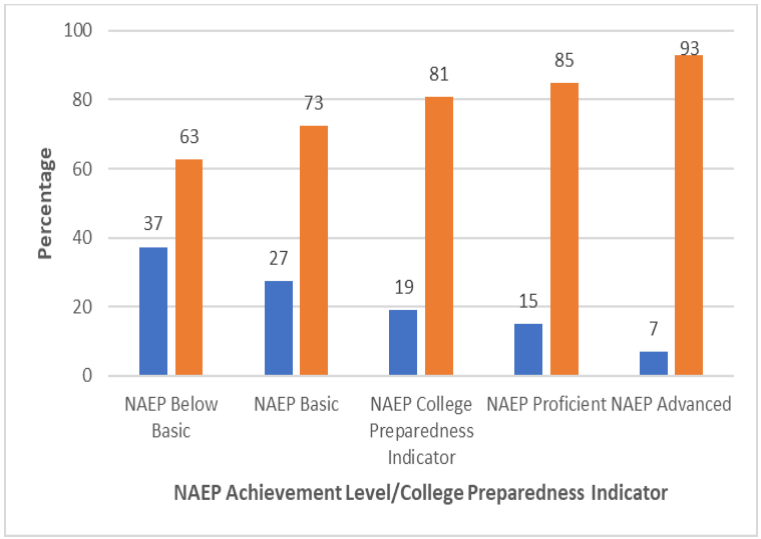
Figure 10. Probabilities of postsecondary persistence in 4-year colleges, by NAEP achievement level, gender, race/ethnicity, and parental education



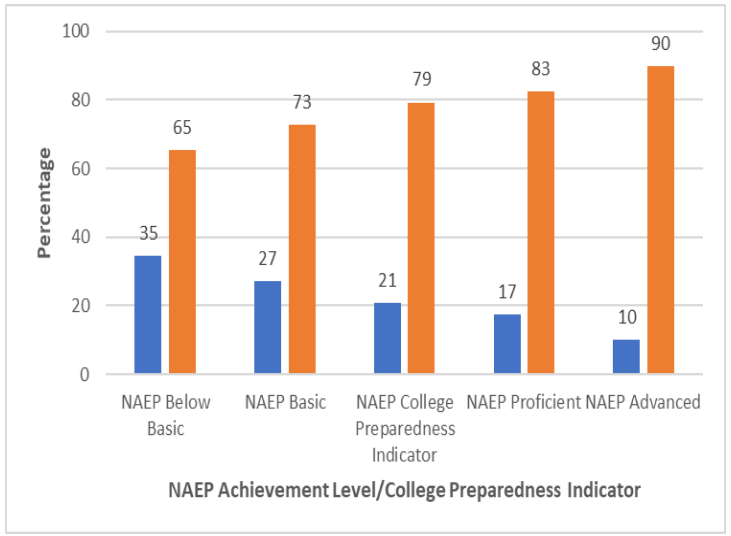
Male



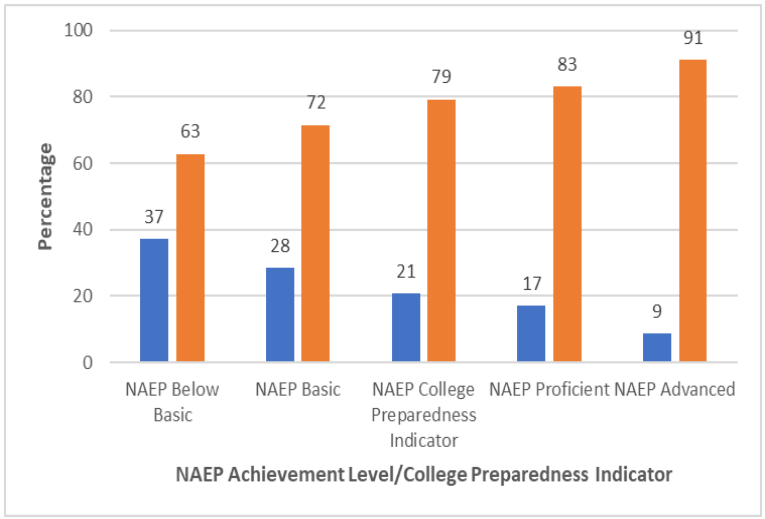
Female



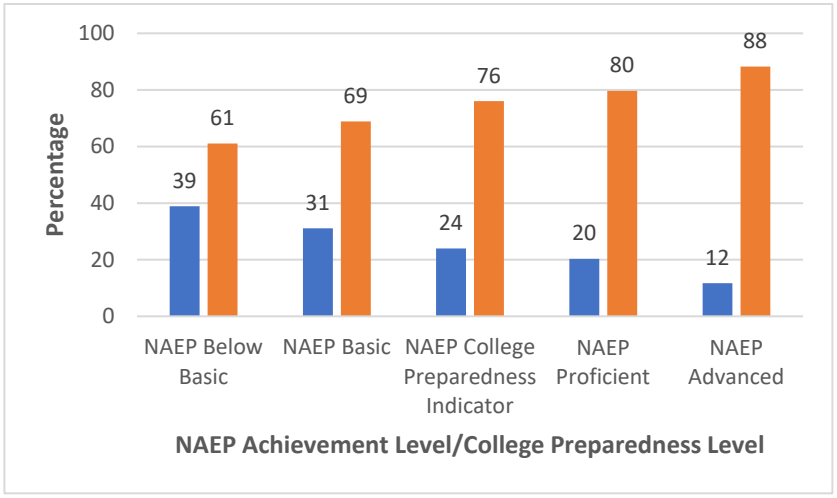
White



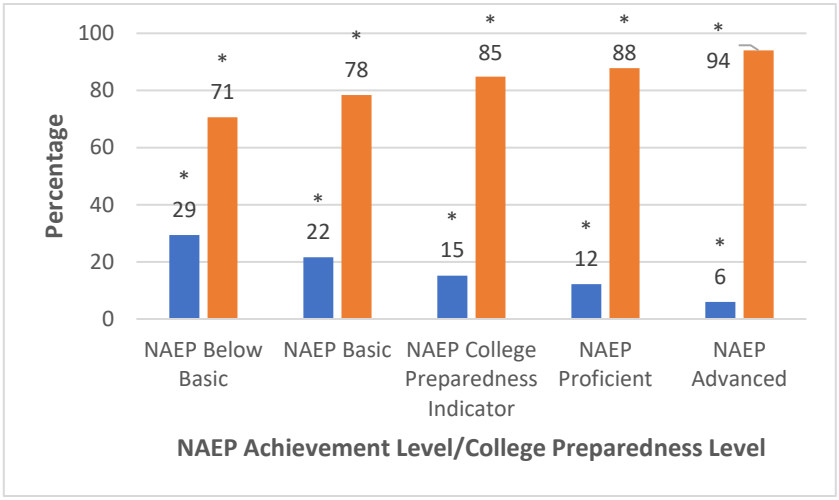
Black



Hispanic



Parental education less than college



Parental education college or higher

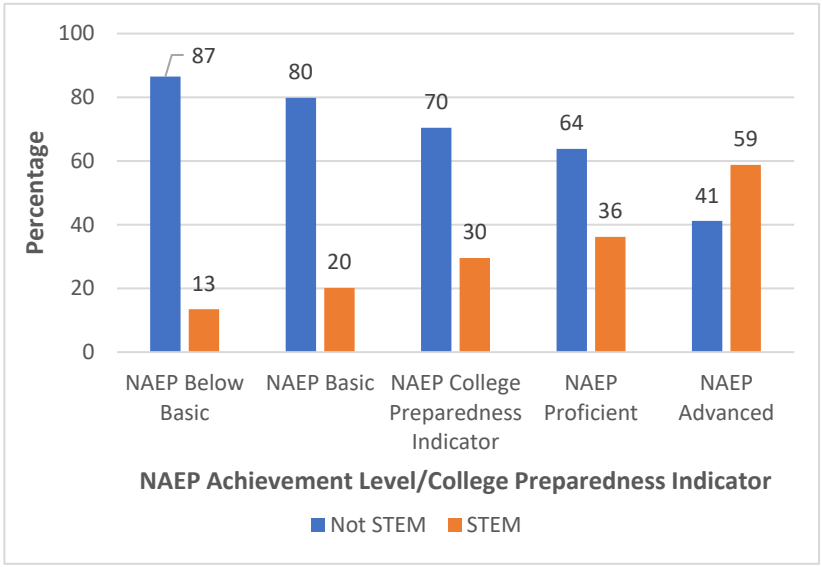
*Significantly different from the reference group (male, White, or parental education less than college).

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09).

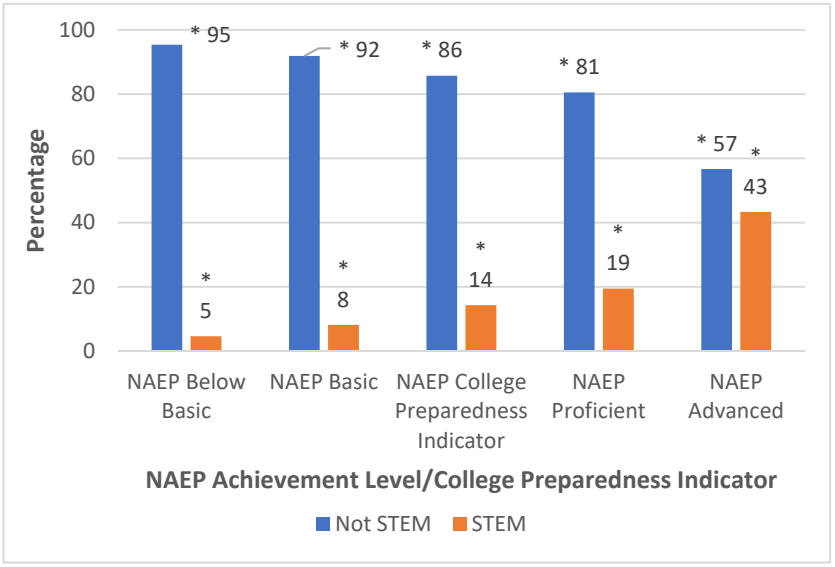
Predicting the Choice of a STEM Major

Figure 11 shows the probabilities of choosing a STEM major in 4-year colleges for all subgroups of interest by NAEP achievement level. Although female students at each NAEP achievement level had higher probabilities of enrolling in 4-year colleges and colleges with higher selectivity than male students, as well as lower probabilities of remedial coursetaking, male students had higher probabilities of choosing a STEM major. In addition, at NAEP's *Basic* and *Proficient* levels, Black students had higher probabilities than White students of choosing a STEM major. However, there were no differences in the probability of choosing a STEM major between students whose parents graduated from college or had advanced degrees and students whose parents had less than college education; this was true at each NAEP achievement level.

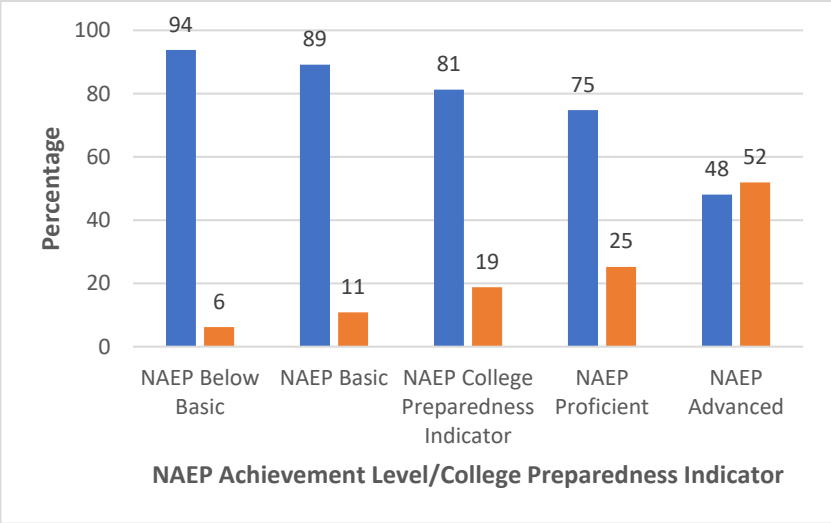
Figure 11. Probabilities of choosing a STEM major in 4-year colleges, by NAEP achievement level, gender, race/ethnicity, and parental education



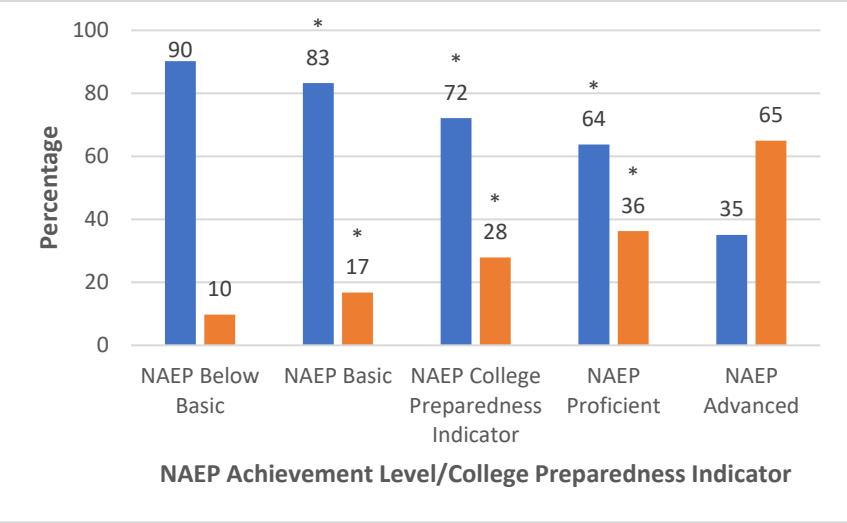
Male



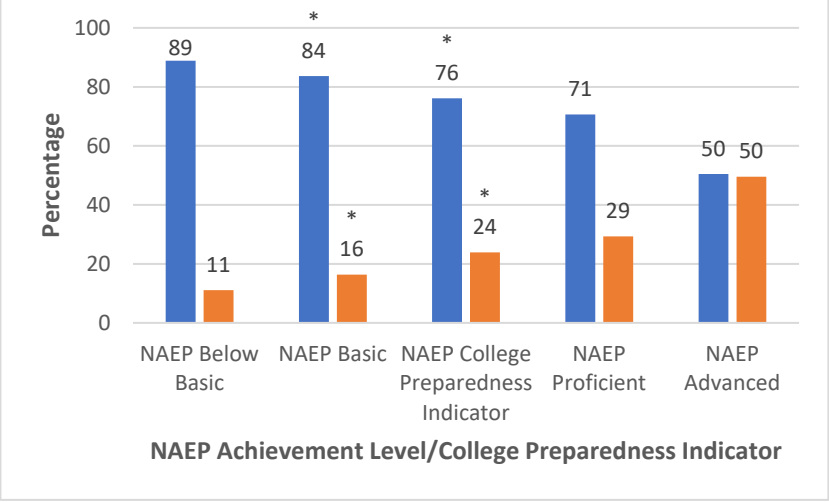
Female



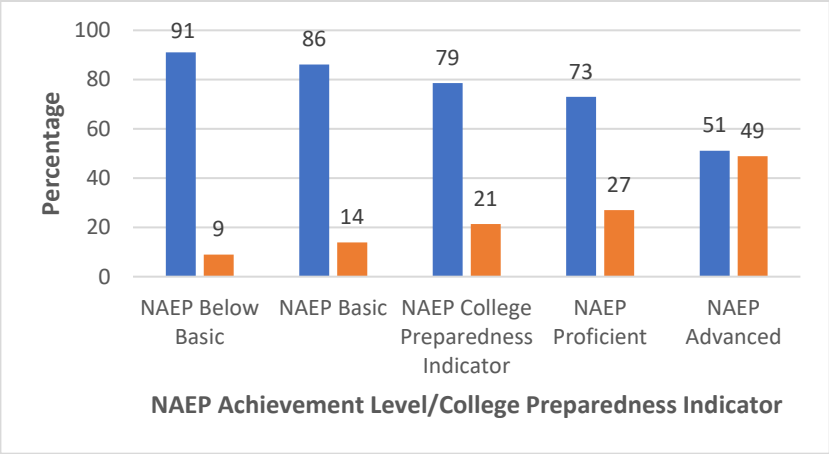
White



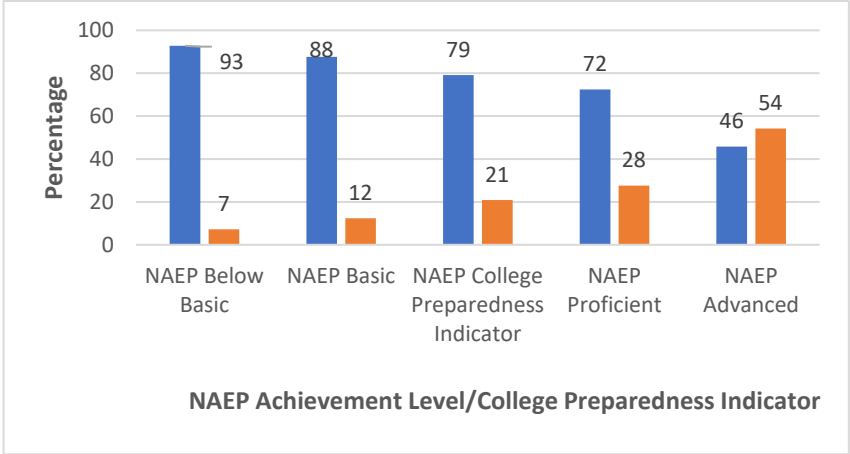
Black



Hispanic



Parental education less than college



Parental education college or higher

*Significantly different from the reference group (male, White, or parental education less than college).

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09).

Comparing NAEP and the SAT in predicting postsecondary outcomes

When colleges make admission decisions, they often use either the SAT or ACT as a measure of achievement, often in combination with overall high school GPA. The set of results displayed below is designed to examine how the NAEP grade 12 Mathematics Assessment compares to the SAT mathematics assessment in the prediction of college enrollment (including the selectivity of the college or university chosen), persistence, remediation, and choosing a STEM major. For these analyses, ordered logistic regression models as described earlier were used, and analyses were limited to the group of students who had SAT scores to ensure the comparability of samples across the SAT and NAEP analyses.

Table A-2 in appendix A compares the two samples. Not surprisingly, students who had SAT scores had higher algebra achievement scores (in grades 9 and 11) and higher GPAs than those in the analytic sample. The SAT analytic sample also appeared to have more male students and higher family SES, but there were no apparent differences in terms of race/ethnicity. The zero-order correlations among the SAT, GPA, and NAEP scale scores are shown in table A-3 in appendix A.

Predicting Enrollment in Postsecondary Education

Table 10 displays the results of the analyses for predicting postsecondary enrollment. In model l, using NAEP scores as the only predictor explains about 20% of the variation in postsecondary enrollment, which is almost identical to using SAT mathematics scores as the only predictor (model 2). When GPA is added as a covariate, the variance explained increased to about 28% for both the NAEP and the SAT models (model 3 vs. model 4). That is, the NAEP grade 12 Mathematics Assessment did as well in explaining the variance in postsecondary enrollment as did SAT mathematics when examined in combination with high school GPA.

Table 10. Comparing NAEP and SAT mathematics scores in predicting postsecondary enrollment

Variable	Model 1	Model 2	Model 3	Model 4
NAEP	0.033 (0.001)***		0.020 (0.002)***	
GPA			1.167 (0.074)***	1.189 (0.064)***
SAT		0.010 (0.000)***		0.006 (0.000)***
Cutoff 1: No college	3.048 (0.195)***	2.783 (0.177)***	4.218 (0.197)***	4.292 (0.195)***
Cutoff 2: 2 years or less	4.816 (0.213)***	4.541 (0.203)***	6.127 (0.207)***	6.210 (0.213)***
Pseudo R^2	0.204	0.198	0.276	0.280
N	10,660	10,660	10,660	10,660

***$p < .001$, **$p < .01$, *$p < .05$.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09).

Predicting Selectivity of Enrolled Colleges

The next set of analyses compared NAEP and the SAT in terms of predicting the selectivity of the college enrolled in (table 11). Comparing models 1 and 2, the results indicate that NAEP explained about 28% of the variance in selectivity, whereas the SAT explained about 30%. When GPA is added to the models, the model that includes NAEP explained 36% of the variance, compared to 39% for the model including SAT and GPA as the predictor variables (model 4). That is, performance on the NAEP grade 12 Mathematics Assessment explained only slightly less variance than SAT mathematics in the prediction of the selectivity of the college enrolled in.

Table 11. Comparing NAEP and SAT mathematics scores in predicting selectivity of college enrolled in

Variable	Model 1	Model 2	Model 3	Model 4
NAEP	0.036 (0.001)***		0.024 (0.002)***	
GPA			1.188 (0.068)***	1.177 (0.056)***
SAT		0.012 (0.000)***		0.008 (0.000)***
Cutoff 1: No college	3.517 (0.181)***	3.312 (0.148)***	4.834 (0.192)***	4.931 (0.176)***
Cutoff 2: 2-year or lower	5.294 (0.190)***	5.089 (0.149)***	6.762 (0.193)***	6.872 (0.175)***
Cutoff 3: Not classified or lower	5.607 (0.194)***	5.411 (0.151)***	7.103 (0.198)***	7.222 (0.179)***
Cutoff 4: Inclusive or lower	6.005 (0.196)***	5.822 (0.152)***	7.533 (0.202)***	7.666 (0.181)***
Cutoff 5: Moderate or lower	7.740 (0.210)***	7.622 (0.163)***	9.355 (0.212)***	9.557 (0.193)***
Pseudo R^2	0.285	0.307	0.357	0.381
N	10,660	10,660	10,660	10,660

***$p < .001$, **$p < .01$, *$p < .05$.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09).

Predicting Enrollment Without Remediation

Table 12 displays the results of the analyses comparing NAEP and the SAT in terms of predicting postsecondary enrollment without remediation. The results indicate that NAEP explained about 17% of the variance, whereas the SAT explained about 16%. When GPA is added to the models, the model that included NAEP explained 23% of the variance, compared to 21% for the model including SAT and GPA as the predictor variables (model 4). These results indicate that SAT and NAEP explained a similar amount of variance in predicting postsecondary enrollment without remediation when the model included high school GPA.

Table 12. Comparing NAEP and SAT mathematics scores in predicting postsecondary enrollment without remediation

Variable	Model 1	Model 2	Model 3	Model 4
NAEP	0.034 (0.001)***		0.023 (0.002)***	
GPA			0.871 (0.078)***	0.925 (0.072)***
SAT		0.011 (0.000)***		0.007 (0.000)***
Cutoff 1: No college	3.116 (0.214)***	2.893 (0.191)***	3.972 (0.208)***	4.062 (0.232)***
Cutoff 2: Less than 2-year	3.277 (0.220)***	3.050 (0.180)***	4.141 (0.208)***	4.229 (0.220)***
Cutoff 3: 2- or 4-year with remediation	4.382 (0.232)***	4.146 (0.190)***	5.295 (0.224)***	5.385 (0.235)***
Pseudo R^2	0.170	0.155	0.216	0.213
N	11,070	11,070	10,660	10,660

***$p < .001$, **$p < .01$, *$p < .05$.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09).

Predicting Persistence in Postsecondary Education

Table 13 displays the results of the analyses comparing NAEP and the SAT in predicting persistence in postsecondary enrollment. The results indicate that NAEP explained about 10% of the variance in persistence, whereas the SAT explained about 13%. When GPA is added to the models, the model that included NAEP explained 12% of the variance, compared to 13% for the model including SAT and GPA as the predictor variables (model 4). These results indicate that the SAT explained a slightly greater amount of variation by itself than did NAEP. However, with the addition of GPA, grade 12 NAEP mathematics explained virtually the same amount of variance in persistence as the SAT mathematics score.

Table 13. Comparing NAEP and SAT mathematics scores in predicting persistence in postsecondary enrollment

Variable	Model 1	Model 2	Model 3	Model 4
NAEP	0.020 (0.002)***		0.009 (0.002)***	
GPA			1.018 (0.111)***	1.034 (0.108)***
SAT		0.006 (0.001)***		0.003 (0.001)**
Cutoff 1: Not persisting in postsecondary	1.703 (0.317)***	1.375 (0.398)***	2.901 (0.346)***	2.852 (0.385)***
Pseudo R^2	0.054	0.050	0.096	0.096
N	9,360	9,360	9,360	9,360

***p < .001, **p < .01, *p < .05.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09).

Predicting the Choice of a STEM major

Table 14 displays the results of the analyses comparing NAEP and the SAT in predicting the choice of a STEM major in 4-year colleges. The results indicate that NAEP explained slightly more variance than the SAT alone—about 10% compared to 9%. Interestingly, when GPA was added to the models, the variance explained did not change for either the NAEP or SAT models—both remained at 10% and 9%, respectively (Models 3 and 4).

Table 14. Comparing NAEP and SAT mathematics scores in predicting the choice of a STEM major

Variable	Model 1	Model 2	Model 3	Model 4
NAEP	0.026 (0.002)***		0.028 (0.002)***	
GPA			−0.150 (0.094)	0.016 (0.078)
SAT		0.007 (0.001)***		0.007 (0.001)***
Cutoff 1: Not choosing a STEM major	5.536 (0.339)***	4.615 (0.306)***	5.348 (0.364)***	4.640 (0.339)***
Pseudo R^2	0.103	0.087	0.104	0.087
N	10,570	10,570	10,570	10,570

***p < .001, **p < .01, *p < .05.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09).

Summary and Discussion

There is an increased focus on ensuring that students are prepared for college when they graduate from high school. As the assessment "gold standard" of measuring what students know and can do, NAEP can potentially inform educators and policymakers on whether the nation's schools have adequately prepared students for college by the time they reach 12th grade. There have been several studies that examined the relationship between NAEP achievement and college admission at the national level and postsecondary entry at the state level (Ogut, Bohrnstedt, Broer, 2019; Fields, 2014). However, this is the first study examining the relationship between NAEP achievement and postsecondary enrollment and other college outcomes using nationally representative data. The results showed that NAEP explained a considerable amount of variation in postsecondary outcomes, with about 28% of the variance explained in overall postsecondary enrollment and about 26% of the variance explained in the selectivity of the colleges enrolled in. However, the variance explained decreased considerably in predicting who chooses a STEM major, remedial coursetaking, and persistence—13%, 10%, and 6%, respectively.

When translated into probabilities of enrollment, the results showed that the *NAEP Basic* level corresponded to a 33% probability of entry into any 4-year college but a 21% probability of entry into a moderately or highly selective 4-year college and a 6% probability of entry into a 4-year not classified or inclusive college. A student at the *NAEP Proficient* level had a 64% probability of entry into any 4-year college, but an 18% probability of enrolling in a highly selective 4-year college, a 33% probability of enrolling in a moderately selective 4-year college, and an 8% probability of enrolling in a 4-year inclusive college. Although NAEP does not have a below *NAEP Basic* cut score, the average NAEP achievement of students who performed below the *NAEP Basic* cut score was used to compute the probabilities of entry into college. The results show that an average student who scored below *NAEP Basic* had a 19% probability of entry into any 4-year postsecondary education institution, a 2% probability of entry into a highly selective college, an 8% probability of enrollment in a moderately selective 4-year college, and an 8% probability of enrolling in a 4-year not classified or inclusive college.

In addition to enrolling in postsecondary education, it is also important to examine whether a student is required to take remedial courses upon enrolling. Remedial coursetaking information was provided by the students themselves and therefore is prone to errors. Perhaps, for this reason, NAEP was not able to predict remedial coursetaking as well as it was able to predict entry into a postsecondary institution. In terms of probabilities, the *NAEP Basic* level was associated with a 49% probability of enrollment in a 2- or 4-year college without remedial coursetaking, whereas the *NAEP Proficient* and *NAEP Advanced* levels were associated with 77% and 94% probabilities of enrollment without remediation, respectively.

The association between grade 12 NAEP mathematics achievement and choosing a STEM major in 4-year colleges (R^2 = 0.171) was lower than that of NAEP's relationship with attending college without remediation (R^2 = 0.234) and overall postsecondary enrollment (R^2 = 0.282). When transformed into probabilities, a student at the *NAEP Basic* achievement level had an 8% probability of choosing a STEM major, compared with 28% for students at the *NAEP Proficient* level and 52% for students at the *NAEP Advanced* level.

The relationship of the NAEP achievement levels and persistence in college had the lowest variance explained, at 6.4%. The results showed that scoring at the *NAEP Basic* level was associated with a 72% probability of persistence, whereas the probability increased to 84% at the *NAEP Proficient* level and 92% at the *NAEP Advanced* level. Perhaps most surprising, of those who scored below *NAEP Basic*, there was a 63% probability of having completed or still being enrolled in college in 2016. The fact that over 50% of the students performing below *NAEP Basic* were enrolled in any college and that by 2016, 63% of them were still enrolled or had completed their studies is noteworthy.

Analyses also examined the relationship between the Governing Board's college preparedness indicator cut point and the various outcomes examined in this study. In all cases, the probabilities generated were slightly lower than those associated with the *NAEP Proficient* level. So, for example, the probability of enrollment in any college, given one was at the *NAEP Proficient* level, was found to be 64%, compared to 53% for someone at the NAEP preparedness cut point. As another example, the probability of enrollment in college without remediation for someone at the *NAEP Proficient* level was 77%, compared to a probability of 68% for someone at the Governing Board's preparedness cut point. Finally, the probability of majoring in STEM at the *NAEP Proficient* level was found to be 28%, whereas the probability at the preparedness cut point was 7 percentage points lower—21 percent. These results provide the first external validity evidence for NAEP's college readiness indicator from nationally representative data.

Taken together, the analyses using the NAEP achievement levels provided substantial evidence of the predictive validity of NAEP for several important college-related outcomes: college attendance, the selectivity of the college attended, whether college is attended without the need for remedial coursetaking, persisting in college once there, and choosing a STEM major. One of the unexpected but important study findings was learning that the probability of choosing a STEM major was 52% for those at the *NAEP Advanced* level on the grade 12 NAEP mathematics assessment. This suggests that the interest and ability in majoring in STEM are high for those who score at this level, but the overall percentage of students who are in the *NAEP Advanced* category remains low (4%).

Research shows that postsecondary enrollment depends on several factors, including academic skills, noncognitive skills, and the availability of information about college systems (Roderic, Nagaoka, & Coca, 2009). Among the factors associated with college entry are academic skills measured by GPA or college entrance exams, students' desire to go to college, SES, the availability of financial aid, parental education, peer effects, and high school involvement (Cartledge, Baldwin, Persall, & Woolley, 2015; Hossler & Gallagher, 1987; Darolia & Koedel, 2018; McDonough & Antonio, 1996; Roderick, Nagaoka, & Coca, 2009). NAEP is a measure of academic skills and, therefore, the results of this study only reflect the association between college enrollment and academic achievement, without taking into account any of the other potentially important factors. Given this, perhaps it should not be surprising that NAEP did not explain a large amount of the variation in postsecondary outcomes examined in the study. However, NAEP performed on a par with the SAT, a test specifically designed for that purpose.

An examination of the relationships between NAEP and the various outcomes by subgroup showed differences, but not always as expected. Perhaps the most surprising one was that at a given NAEP achievement level, Black students had higher probabilities of postsecondary enrollment than White or Hispanic students. The study's examination of the selectivity of colleges enrolled in revealed that both Black and White students had higher probabilities than Hispanic students of enrollment in more, rather than less, selective colleges. White and Black students also had higher probabilities than Hispanic students of choosing STEM majors. White and Black students also had higher probabilities of postsecondary enrollment without remediation than did Hispanic students. There were no apparent differences in persistence across different racial/ethnic groups, but female students appeared more likely than male students to persist. It should be noted that the actual percentages of Hispanic and Black students at the *NAEP Proficient* and *NAEP Advanced* achievement levels (which are associated with higher positive outcome probabilities, regardless of group membership) are lower than those of White students.

The higher probabilities of postsecondary enrollment for Black students could be due to affirmative action or to the efforts of college administration offices to ensure a diverse student population. However, one would have expected affirmative action to have a similar effect on Hispanic students' enrollment probabilities at a given performance level, but they actually had lower probabilities of enrolling in colleges with higher selectivity. Studies show that financial aid is a significant predictor of the gap in enrollment between 2- and 4-year colleges for Hispanic students (O'Connor, Hammack, & Scott, 2010). Higher percentages of Hispanic students at 2-year colleges were also observed in HSLS:09. The higher likelihood of admission of Black students to inclusive and moderately selective colleges also points to the potential interaction between academic achievement and other factors, such as SES.

The study also found that at each achievement level, female students had higher probabilities of postsecondary enrollment, enrolling in colleges with higher selectivity, enrolling without the need for remedial coursetaking, and persisting in college than male students. However, male students had higher probabilities than females of choosing STEM majors in 4-year colleges. Historically, males have had a higher rate of college attendance than females. For example, in 1970, 32% of 18- to 24-year-old males were enrolled in college, compared to 20% of females of the same age. By 2015, a higher percentage of females than males were enrolled—the comparable percentages were 38 and 43 percent.[9] That is, over a 45-year period, college attendance for males increased by 18%, but for females the increase was much larger—113%.

The fact that this study identified female students as having higher probabilities of enrollment, enrollment without remediation, enrolling in highly selective colleges, and persistence may be due to several factors. First, the results observed might reflect the use of gender as a factor in admission decisions. Second, the results that show males as being more likely to attend selective colleges are outdated and may not reflect female students' increasingly high educational expectations, thereby resulting in more female students applying, and being admitted, to college in general and more selective colleges in particular. Finally, there might also be differences between male and female students in noncognitive factors associated with better outcomes.

In terms of SES, students with higher SES had a higher probability of enrollment, enrolling in highly selective colleges, and enrolling without remedial courses than those with lower SES. These results are in line with the literature that shows that lower SES students are less likely to attend postsecondary colleges than are higher SES students (Long, Conger, & Latarola, 2012). However, there were no differences between students with lower SES and students with higher SES in choosing STEM majors.

The results from this study showing different probabilities for postsecondary outcomes by subgroup do not necessarily suggest that students from different backgrounds are favored or being discriminated against. The results are mostly in line with the literature and reinforce the idea that academic skills, as reflected by NAEP achievement, are only one of the factors affecting the probability of postsecondary entry; other factors include socioeconomic status, financial aid, and students' educational aspirations (Cartledge, Baldwin, Persall, & Woolley, 2015; Darolia & Koedel, 2018; Roderick, Nagaoka, & Coca, 2009). The differences in any of these factors across student groups could lead to varying probabilities of college enrollment.

The current study also compared the performance of the grade 12 NAEP mathematics assessment against the SAT mathematics assessment in predicting college enrollment. The

[9] See https://nces.ed.gov/programs/digest/d16/tables/dt16_302.60.asp.

results showed that they performed similarly, explaining about 20% of the variance in postsecondary enrollment and about 30% of the variance in the selectivity of the college enrolled in. The NAEP and SAT mathematics assessments also performed similarly in terms of the prediction of remedial coursetaking, postsecondary persistence, and choosing a STEM major, explaining, on average, 12%, 5%, and 9.5% of the three variances, respectively. These results suggest that the NAEP grade 12 Mathematics Assessment did as well in explaining the variance in these outcomes as the SAT mathematics assessment did when both were looked at in combination with overall high school GPA. These findings provide further validation of NAEP as a measure of college preparedness.

Taken together, the findings from the study provide strong evidence of the predictive validity of NAEP for a set of important outcomes related to college enrollment and attendance. This concerns not only the predictive validity of NAEP in general but also the NAEP achievement levels as well as the mathematics college preparedness indicator. The results of this study can further be used to identify alternative cut points on the NAEP scale (such as a 50%, 66%, or 75% chance of a positive outcome).

It should be noted that the current results are nationally representative but are based on only two (enrollment and remedial coursetaking but not first-year college GPA of 2.7 or higher) of the three criteria that the Governing Board uses in defining college preparedness (Fields, 2014). Missing is GPA at the end of the college freshman year. Nevertheless, this study offers the best evidence yet of the validity of grade 12 NAEP mathematics achievement as a preparedness indicator. Another limitation of the study is that remedial coursetaking was self-reported. These limitations will be addressed in an upcoming follow-on study that incorporates HSLS:09's recently released college transcript data, which includes actual instead of reported remedial coursetaking and first-year GPA. Indeed, the transcript data, which will include GPA through the completion of college, will provide an even better test of how well the Governing Board's mathematics preparedness indicator predicts overall college academic performance.

References

ACT. (2017). *The Condition of College & Career Readiness 2017*. Retrieved, July 1, 2018, from http://www.act.org/content/dam/act/unsecured/documents/cccr2017/CCCR_National_2017.pdf.

Allensworth, E.M., and Easton, J.Q. (2007). *What Matters for Staying On-Track and Graduating in Chicago Public High Schools: A Close Look at Course Grades, Failures, and Attendance in the Freshman Year*. Chicago: University of Chicago, Consortium on Chicago School Research.

Cartledge, B.H., Baldwin, M., Persall, J.M., and Woolley, T. (2015). College Choice Determinants of African-American Enrollment at a Private College. *Journal of Academic Administration in Higher Education*, *11*(1): 1–8.

Darolia, R., & Koedel, C. (2018). High Schools and Students' Initial Colleges and Majors. *Contemporary Economic Policy, 36*(4): 692–710.

Fields, R. (2014). *Towards the National Assessment of Educational Progress (NAEP) as an Indicator of Academic Preparedness for College and Job Training*. Washington, DC: National Assessment Governing Board.

Fields, R. (2013). *Validity Argument for NAEP Reporting on 12th Grade Academic Preparedness for College*. Washington, DC: National Assessment Governing Board

Hossler, D., and Gallagher, K.S. (1987). Studying Student College Choice: A Three-Phase Model and the Implications for Policymakers. *College and University, 62*(3): 207–221.

Long, M.C., Conger, D., and Iatarola, P. (2012). Effects of High School Course-Taking on Secondary and Postsecondary Success. *American Educational Research Journal 49*(2): 285–322.

McDonough, P., and Antonio, A.L. (1996, April). Ethnic and Racial Differences in Selectivity of College Choice. Paper presented at the Annual Meeting of the American Educational Research Association, New York.

Mishook, J., Gurantz, O., Borsato, G.N., Hewitson, M., Martinez, M., McGinnis, E., et al. (2012). *College Readiness Indicator Systems*. Providence, RI: Annenberg Institute, Brown University. Retrieved May 16, 2021, from http://annenberginstitute.org/sites/default/files/VUE35a.pdf.

O'Connor, N., Hammack, F. M., and Scott, M. A. (2010). Social Capital, Financial Knowledge, and Hispanic Student College Choices. *Research in Higher Education, 51*(3): 195–219. https://doi.org/10.1007/s11162-009-9153-8.

Ogut, B., Bohrnstedt, G., and Broer, M. (2019). *Examining the Ability of Grade 12 NAEP Mathematics to Predict College Admissions Immediately Out of High School*. Washington, DC: American Institutes for Research.

Ogut, B., Bohrnstedt, G., & Broer, M. (2015). *Imputing 12th-grade NAEP Mathematics Scores for the Full HSLS Sample*. Washington, DC: American Institutes for Research.

Radford, A.W., and Horn, L. (2012). *Web tables—An Overview of Classes Taken and Credits Earned by Beginning Postsecondary Students* (NCES 2013-151REV). Washington, DC: National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education.

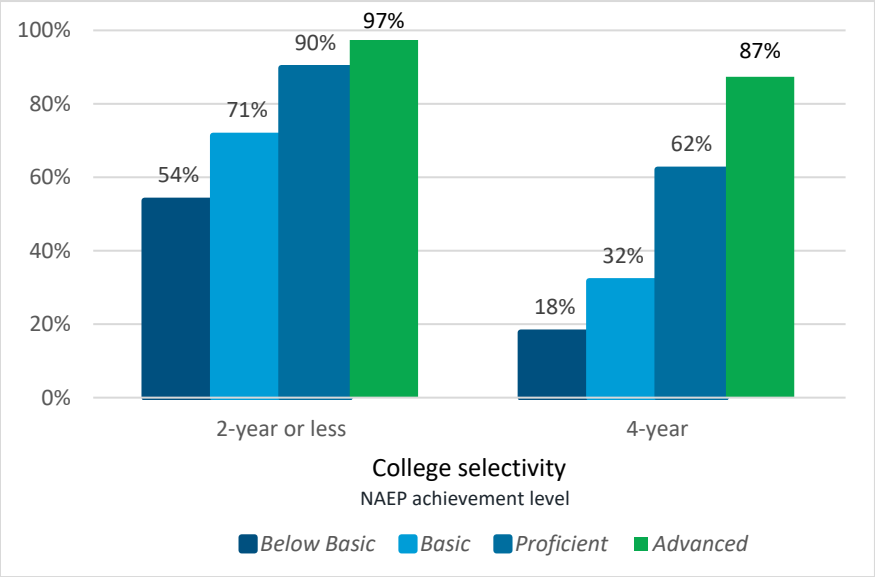
Roderick, M., Nagaoka, J., and Coca, V. (2009). College Readiness for All: The Challenge for Urban High Schools. *The Future of Children, 19*(1): 185–210. https://doi.org/10.1353/foc.0.0024.

Skomsvold, P. (2014). *Profile of Undergraduate Students: 2011-12* (NCES 2015-167). Washington, DC: National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education.

Appendix A

Figure A-1 below shows the probabilities of postsecondary enrollment under a scenario where students are assumed to have been able to enroll in a lower postsecondary education level than that for which they are qualified. The results show that a student at the *NAEP Advanced* level has a 97% probability of enrolling in a 2-year or less college, a student at the *NAEP Proficient* level has a 90% probability, a student at the *NAEP Basic* level has a 71% probability, and a student scoring below *NAEP Basic* has a 54% probability.

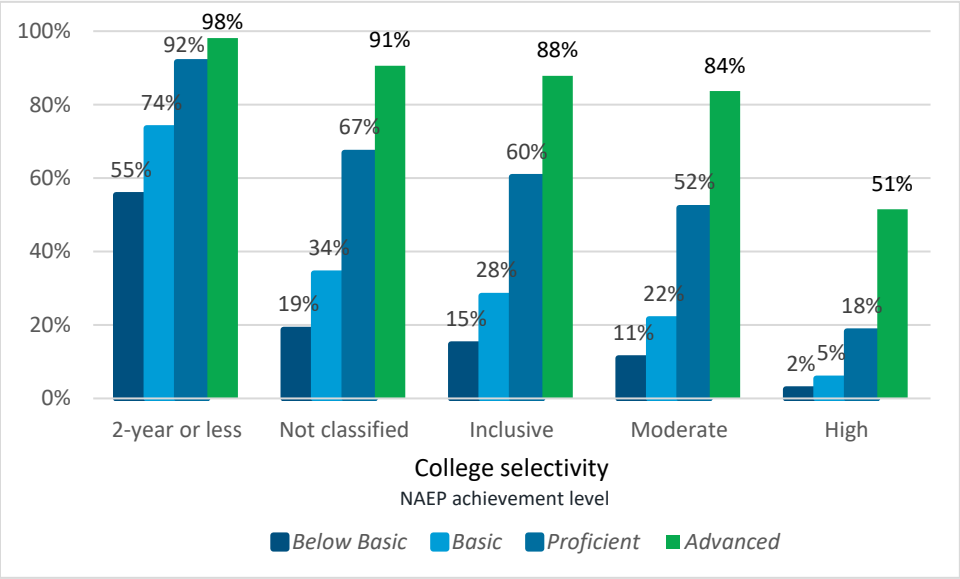
Figure A-1. Cumulative probabilities of postsecondary enrollment



SOURCE: U.S. Department of Education, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09).

Figure A-2 shows the cumulative probabilities of enrolling in colleges with different degrees of selectivity. Not surprisingly, students at the *NAEP Advanced* level have the highest cumulative probability of enrollment in a moderately selective college (82%), whereas a below *NAEP Basic* student has the lowest probability (10%).

Figure A-2. Cumulative probabilities of enrolling in colleges with different degrees of selectivity, by NAEP achievement level



SOURCE: U.S. Department of Education, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09).

Table A-1. Comparison of analytic sample with NAEP operational sample

Variable	Analytic Sample	NAEP Sample
Percentages		
White	54	58
Black	13	14
Hispanic	21	20
Asian	4	6
Other race	8	3
Male	50	51
Scores		
NAEP score	150.62	153

#Rounds to zero.

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09).

Table A-2. Comparison of SAT analytic sample with main analytic sample

	SAT analytic sample (*N* = 10,660)		Main analytic sample (*N* = 14,000)	
Group	**Mean**	**SD**	**Mean**	**SD**
Percentages				
White	57%	49%	54%	50%
Black	14%	34%	13%	33%
Hispanic	17%	37%	21%	41%
Asian	4%	21%	4%	20%
Other race	8%	27%	8%	28%
Male	47%	50%	50%	50%
Parent college graduate	44%	50%	37%	48%
Income higher than $55K	57%	49%	51%	50%
Scores				
Algebra, grade 11	53.35	9.61	50.91	9.97
Algebra, grade 9	53.02	9.44	50.82	9.83
GPA	2.97	0.66	2.70	0.80

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09).

Table A-3. Correlations among GPA, SAT math, and NAEP scale scores

	NAEP scale score (Enrollment)	NAEP scale score (Selectivity)	NAEP scale score (Persistence)	NAEP scale score (Remediation)	NAEP scale score (STEM)	GPA	SAT math
NAEP scale score (enrollment)	1.00						
NAEP scale score (selectivity)	1.00	1.00					
NAEP scale score (persistence)	0.79	0.79	1.00				
NAEP scale score (Remediation)	1.00	1.00	0.79	1.00			
NAEP scale score (STEM)	0.81	0.81	0.77	0.81	1.00		
GPA	0.67	0.66	0.62	0.67	0.67	1.00	
SAT math	0.74	0.74	0.72	0.74	0.73	0.58	1.00

SOURCE: U.S. Department of Education, National Center for Education Statistics, High School Longitudinal Study of 2009 (HSLS:09).

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