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Using SAT® Scores to Inform Academic Major-Related Decisions and Planning on Campus

PAUL A. WESTRICK, JESSICA P. MARINI, AND EMILY J. SHAW

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Executive Summary

This study explored how the SAT and HSGPA can work together to help institutions to confidently admit, place, and support students in their academic majors while promoting student opportunity and success as well as institutional health and success. In particular, this study examined the differential validity of the SAT for predicting second-year cumulative grade point average (SYCGPA) and students' chances of earning a SYCGPA of 3.0 or higher across 13 academic majors, with a special emphasis on STEM majors and STEM students who come from educationally disadvantaged environments. This information can be helpful for campus initiatives focused on major choice, academic success within major (as measured by grades), and retention within major.

Correlational analyses indicated that although the relationships between the SAT and SYCGPA varied across the majors, the SAT was a strong predictor of SYCGPA for all 13 academic majors included in the study, and the SAT was stronger than HSGPA as a predictor of SYCGPA in nearly half of the academic majors. This finding suggests that most validity research, which does not account for students' academic majors, underestimates the validity of the SAT and the incremental validity of the SAT above HSGPA.

Logistic regression analyses found that SAT scores added information about student success at all points of the HSGPA scale for all 13 academic majors. For students with the same HSGPA, their chances of earning a SYCGPA of 3.0 or higher varied depending on their SAT scores, and this was found across all academic majors included in the study. Analyses also indicated that students' chances of earning a SYCGPA of 3.0 or higher varied across academic majors, despite having the same SAT scores and HSGPAs, suggesting that college grading practices varied across academic majors and predictive models of student success are most useful when considered within academic departments.

Across levels of environmental context, the inclusion of SAT scores dramatically reduced the gap in predicted success when compared to results found using HSGPA alone. As many institutions aim to diversify their STEM student bodies, they may need to be aware of academic support services that would be helpful to implement to ensure that all students can be successful in those majors and not just students from educationally advantaged environments.

Subgroup analyses found that STEM students who came from educationally disadvantaged environments had lower probabilities of earning a SYGPA of 3.0 or higher even when they had the same SAT scores and HSGPAs of their peers, suggesting that these students may benefit from increased institutional support as colleges and universities seek to diversify the student body in the STEM fields. Paying attention to both SAT scores and environmental context information can help institutions to target instructional supports to the students that need them most to ensure that all students have the opportunity to be successful in their chosen major and have additional opportunities later on for graduate school and recruitment by top employers, that may in part be selected by cumulative GPA .

Introduction

The goal of the current study is to provide institutional SAT score users with information that can help them understand how the students they admit will perform in various academic majors, especially STEM majors, and use this information to support students appropriately. With the introduction of the new SAT in 2017, College Board established a validity research agenda to examine the validity of the SAT as a predictor of undergraduate academic performance and retention, from the beginning of college through graduation. As part of this ongoing series of research studies, the current study examines the validity of the SAT for predicting second-year cumulative grade point average (SYCGPA) across different academic majors, with a special emphasis on STEM majors.

Literature Review

Grade point average (GPA) has long stood as the collective measure of students' academic performances, and it has been one of the most, if not the most, common outcome criteria of college education research (Beatty, Walmsley, Sackett, & Kuncel, 2015; Westrick, 2017). Though the use of GPA as a measure of academic performance has been ubiquitous, there has always been the acknowledgement—often unspoken—that undergraduate GPA represents something different for each student at each institution. Grading standards can vary across courses, instructors, academic semesters, and institutions. Though there may be some course overlap among students, what undergraduate GPA represents differs across students depending on the other courses they take at their institutions. In reality, undergraduate GPA is a unique measure for each student.

Given the uniqueness of undergraduate GPA for each student, the use of college GPA as a common criterion has proven to be a challenge in predictive validity research. To address this issue, researchers have taken a variety of approaches to compensate for the variation in the courses taken by students and the grading standards across courses. Some researchers have examined validity at the individual course level by making grade adjustments (Berry & Sackett, 2009; Stricker, Rock, & Burton, 1993; Young, 1990a, 1990b, 1993), and others have taken broad-based approaches that looked at grades earned by students in individual majors or by categorizing students by what we would now consider STEM and non-STEM majors (Bridgeman, Pollack, & Burton, 2008; Elliott & Strenta, 1988; Goldman & Hewitt, 1975, 1976; Goldman, Schmidt, Hewitt, & Fisher, 1974; Goldman & Widawski, 1976; Hewitt & Jacobs, 1978; Morgan, 1990; Oh, 1976; Pennock-Roman, 1994; Prather & Smith, 1976; Prather, Smith, & Kodras, 1979; Shaw, Kobrin, Patterson, & Mattern, 2012; Strenta & Elliott, 1987). In general, these studies found that grading practices differed across academic majors, and that grading standards were harder in STEM majors than they were in non-STEM majors.

The focus on STEM dates back at least to the Cold War and remains at the forefront of discussions on the current economic competition in the global economy (Institute of Medicine, 2007; National Academies of Sciences, Engineering, and Medicine (NASEM), 2016a; National Research Council, 2012; Super & Bachrach, 1957). Given the importance assigned to the identification, selection, and development of future scientists, engineers, and mathematicians, education researchers have focused on the profiles of STEM students, and the literature has shown that students in STEM majors tend to have higher average test scores and HSGPAs than do students in other majors (Chen, 2009; Elliott & Strenta, 1988; Goldman & Hewitt, 1975, 1976; Goldman, et al., 1974; Goldman & Widawski, 1976; NASEM, 2016b; Minaya, 2020; Nicholls, Wolfe, Besterfield-Sacre, Shuman, & Larpkiattaworn, 2007; Ost, 2010; Pennock-Roman, 1990, 1994; Strenta & Elliott, 1987, Strenta, Elliott, Adair, Matier, & Scott, 1994, Super & Bachrach, 1957; White, 1992). Moreover, many of these researchers found that the key differentiator between STEM and non-STEM majors was mathematics performance.

With the extended focus on STEM students, academic tilt emerged as a factor relevant to understanding who goes into STEM majors and careers. Academic tilt, a relative academic strength in one academic area as opposed to another, has been associated with students' choices of academic majors (Coyle, Purcell, Snyder, & Richmond, 2014; Davison, Jew, & Davenport, 2014; Lubinski & Benbow, 2007; Lubinski, Webb, Morelock, & Benbow, 2001; Shea, Lubinski, & Benbow, 2001). Students with a relative strength in mathematics were found to be more likely to choose a STEM major in college, and students with a language or verbal tilt were more likely to choose a major in the humanities or social sciences.

As described above, there has been a great deal of interest in the characteristics of students who go into STEM majors. In recent years, the discussions on STEM student characteristics have turned to include calls to increase student diversity in STEM (NASEM, 2016b, 2019). More women and underrepresented minorities are entering STEM fields than they did in the past, but males still outnumber females in engineering, mathematics, and computer science, and most of the students entering STEM fields are White (NASEM, 2016b). Recent College Board research has reported that underrepresented minorities in college are more likely to come from educationally disadvantaged environments, and students of all racial/ethnic groups who come from educationally disadvantaged environments perform slightly lower than, but about as well as, they are predicted to perform, based on their SAT scores and HSGPAs (Westrick, Young, Shaw, & Shmueli, 2020). Given that the literature reports that grading standards are stricter in STEM majors than in other majors, how STEM students from educationally disadvantaged environments perform in college relative to their peers is a subject that needs further investigation.

Ultimately, examining academic predictors of college performance by academic major and how relative student strengths may factor into understanding performance by major, institutions can better inform their enrollment planning processes by academic department. This can contribute to more effectively fulfilling various mission-oriented initiatives to increase student diversity in particular major fields and more efficient planning for departmental logistics, such a course scheduling, support services to offer, and faculty hiring (Massa & Parker, 2007; Ohland, Sheppard, Lichtenstein, Eris, Chachra, & Layton, 2008). In particular, this study explores how the SAT and HSGPA can work together to help institutions make the most informed decisions that promote student opportunity and success as well as institutional health and success. There will be a special focus on understanding how the use of SAT with HSGPA can provide the most robust information and opportunities for students from Educationally disadvantaged environments to enable and support their positive STEM major outcomes.

Methodology

Sample

College Board broadly recruited four-year institutions with at least 250 first-year students (at least 75 of those students had to have SAT scores) to participate in a national SAT validity study. These institutions provided data through College Board's secure online Admitted Class Evaluation Service (ACES™) system. Ultimately, 73 institutions provided the complete student-level information and had enough students within academic majors needed for the analyses that follow in this section of the report.

Table 1 includes the characteristics of the 73 four-year colleges and universities in the sample and shows that the institutional sample is quite diverse with regard to region of the U.S., control (public/private), selectivity, and size. Compared to the population[1] of four-year institutions for this study, the institutional study sample included more public institutions, and more "large" and "very large" institutions than the reference population. The oversampling of larger institutions is to be expected as there was a sample size minimum to participate in the study.

Table 1: Institutional Characteristics of the Study Sample and Population of Four-Year Institutions

	Variable	**Study Sample (*k*=73)**	**Reference Population of Institutions (*k*=1,230)**
U. S. Region	Midwest	19 (26%)	343 (28%)
	Mid-Atlantic	15 (21%)	246 (20%)
	New England	8 (11%)	119 (10%)
	South	14 (19%)	277 (23%)
	Southwest	6 (8%)	90 (7%)
	West	11 (15%)	155 (13%)
Control	Public	36 (49%)	417 (34%)
	Private	37 (51%)	813 (66%)
Admittance Rate	Under 25%	4 (5%)	57 (5%)
	25% to 50%	15 (21%)	211 (17%)
	51% to 75%	30 (41%)	651 (53%)
	Over 75%	24 (33%)	311 (25%)
Undergraduate Enrollment	Small	32 (44%)	761 (62%)
	Medium	10 (14%)	202 (16%)
	Large	12 (16%)	136 (11%)
	Very Large	24 (26%)	131 (11%)

Note. *k* = number of institutions. Percentages may not sum to 100 due to rounding. Undergraduate enrollment was categorized as follows: small: 4,999 or less; medium: 5,000 to 9,999; large: 10,000 to 19,999; and very large: 20,000 or more.

[1] The population included four-year public or private nonprofit institutions that accepted 90% or fewer applicants for admission.

Inclusion in the study sample required students to have redesigned SAT scores, a valid self-reported HSGPA, a valid first-year grade point average (FYGPA) supplied by the institution, retention to the second year at the same institution attended in the first year[2], a second-year cumulative GPA (SYCGPA) supplied by the institution, and a declared major in one of the academic majors that had a sufficient number of students for analyses. This resulted in a sample size of 54,924 students. Table 2 provides more information about the characteristics of the student sample and the population of 2017 graduating seniors who took the redesigned SAT. Compared to the population, the study sample, which included students who were enrolled in college and retained to the second year at the same institution, tended to have slightly more female students, slightly more White students and fewer Black or African American students and Hispanic or Latino students, and more students whose highest parental education level was a bachelor's degree or higher than the overall SAT-taking population.

Table 2: Student Characteristics of the Study Sample and 2017 Graduating Seniors with SAT Scores

	Variable	**Study Sample (n = 54,924)**	**2017 Graduating Seniors who took the SAT (N = 1,715,481)**
Gender	Male	24,050 (44%)	809,462 (47%)
	Female	30,874 (56%)	906,019 (53%)
Race/Ethnicity	American Indian or Alaska Native	129 (<1%)	7,782 (<1%)
	Asian	5,239 (10%)	158,031 (9%)
	Black or African American	3,756 (7%)	225,860 (13%)
	Hispanic or Latino	9,445 (17%)	408,067 (24%)
	Native Hawaiian or Other Pacific Islander	66 (<1%)	4,131 (<1%)
	White	33,540 (61%)	760,362 (44%)
	Two or More Races	2,119 (4%)	57,049 (3%)
	Not Stated	630 (1%)	94,199 (5%)
Highest Parental Education Level	No High School Diploma	2,551 (5%)	137,437 (8%)
	High School Diploma	10,405 (19%)	482,194 (28%)
	Associate Degree	3,724 (7%)	134,451 (8%)
	Bachelor's Degree	21,109 (38%)	473,103 (28%)
	Graduate Degree	16,532 (30%)	339,743 (20%)
	Not Stated	603 (1%)	148,553 (9%)

[2] Note that previous College Board research on this 2017 cohort of students found that the overall retention rate to the same institution for first-year students was 83% (Westrick et. al., 2019), and that the retention rates for under-represented minorities were somewhat lower (Marini et al., 2019). Students not retained to the second year had, on average, lower SAT scores and HSGPAs compared to students who were retained to the second year. Consequently, aside from the correlational analyses that accounted for range restriction, the relationships between our predictors and other outcomes of interest, earning a SYGPA of 3.0 or higher and retention to the third year, are in all likelihood stronger than what was found in the current study.

To conduct the analyses at the academic major level, students had to have a declared major at the end of their second year of college. Institutions reported this information for students using Classification of Instructional Programs (CIP) codes developed by the National Center for Education Statistics (NCES, 2010). In the current study, we used the two-digit CIP codes and the corresponding CIP titles to categorize students' academic majors. For inclusion in the study, there had to be at least 15 students within a two-digit CIP code at an institution. Not all academic majors are offered at every institution, so to avoid having small samples that may have been highly unrepresentative, we further required that an academic major had to be represented at 20 institutions or more for inclusion in the study. The final number of academic majors with at least 20 institutions with at least 15 students in a given major was 13. These academic majors, their two-digit CIP codes, the number of institutions (*k*), and number of students (*n*) are presented in Table 3.

Table 3: Academic Majors Included in the Study

Academic Major/CIP Title (two-digit CIP code)	***k***	***n***
Biological and biomedical sciences (26)*	60	8,034
Business, management, marketing, and related support services (52)	58	10,064
Communication, journalism, and related programs (9)	37	2,201
Computer and information sciences and support services (11)*	34	2,403
Education (13)	39	2,307
Engineering (14)*	33	7,422
English language and literature/letters (23)	26	802
Health professions and related programs (51)	49	6,267
Liberal arts and sciences, general studies, and humanities (24)	37	5,189
Mathematics and statistics (27)*	20	761
Physical sciences (40)*	34	1,518
Psychology (42)	50	3,299
Social sciences (45)	53	4,657
Note. CIP=classification of instructional program; * indicates STEM majors.		

Measures

High School GPA (HSGPA). Students' self-reported HSGPA was obtained from the SAT Questionnaire when they registered for the SAT and is reported on a 12-point interval scale, ranging from 0.00 (F) to 4.33 (A+). Institutional HSGPA could not be used in this national study because it is reported on so many different scales across institutions. Note that the inclusion of self-reported HSGPA is consistent with previous admission test validity studies (e.g. Mattern and Patterson, 2014; Sawyer, 2013) and studies have found self-reported HSGPA to be highly correlated with actual HSGPA (Kuncel, Credé, & Thomas, 2005; Shaw & Mattern, 2009). In the class of 2017, 93% of the SAT-taking population reported their HSGPA. The HSGPA measure in this study had a sample mean of 3.73 (SD=0.44).

SAT Scores. SAT scores were obtained from College Board's database and matched to each student provided in the institution files. The SAT scores included in this study are:

> **SAT Total Score (400 to 1600 scale)**—increments of 10, sample mean of 1210 (SD=157).
>
> **SAT Evidence-based Reading and Writing (ERW) Section Score (200 to 800 scale)** —increments of 10, sample mean of 606 (SD=79).
>
> **SAT Math Section Score (200 to 800 scale)** —increments of 10, sample mean of 604 (SD=90).

SAT Tilt. We created the SAT tilt measure to determine whether a students' relative strength is on the SAT ERW section or the SAT Math section. First, we used the 2017 SAT population to create standardized z-scores for both ERW Section scores and Math section scores.[3] We then subtracted the SAT ERW z-score from the SAT Math z-score to get each student's SAT tilt. Positive SAT tilt indicates that a student's relative strength was on the SAT Math section. Negative SAT tilt indicates that a student's relative strength was on the SAT ERW section. Most students have a small amount of SAT tilt. In the study sample, the mean SAT tilt was 0.00 (SD=0.63) and ranged from -3.1 to 3.6.

Environmental Context Quintiles. Environmental context is measured by neighborhood and high school percentiles for six indicators related to educational opportunities and/or disadvantages students may experience based on where they live and learn: college attendance, crime, education level, household structure, housing stability, and median family income. The neighborhood level is defined by a student's census tract, and the high school level is defined by the census tracts of college-bound seniors at a high school. Applicants from the same census tract share the same neighborhood data and indicators; applicants from the same high school share the same high school data and indicators. At both the neighborhood and high school levels, these six indicators are averaged and presented on a 1—100 scale to provide a neighborhood average and a high school average. A higher value on the 1—100 scale indicates a higher level of challenge related to educational opportunities and outcomes. For this study, these two averages are averaged, and then these percentiles are in turn split into quintiles, with students in the top 20% representing students from the most challenging environments, in Context Quintile 5. This is done for each quintile, with students in the bottom 20%, students from the least challenging environments, in Context Quintile 1.[4]

College Grades. Each institution provided FYGPA and SYCGPA values for their fall 2017 first-time, first-year students. Across the 73 institutions in this sample, FYGPA had a sample mean of 3.21 (SD=0.59), and SYCGPA had a sample mean of 3.20 (SD=0.58).

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[3] We used the 2017 SAT examinees who reported HSGPA (n=1,594,136) as HSGPA was required for inclusion in the study.

[4] For detailed information on the data and methodology behind environmental context, please visit https://secure-media.collegeboard.org/landscape/comprehensive-data-methodology-overview.pdf. For additional information on Landscape, a tool that helps colleges consider environmental context in the application review process, please visit cb.org/landscape.

Descriptive Statistics

Table 4 includes descriptive statistics for all measures of interest in the sample and for the 2017 graduating seniors who took the SAT. As the sample includes students enrolled in college into the second year, it is not surprising that these students are academically stronger than the total SAT test-taking population across all measures. Descriptive statistics are reported for all SAT scores utilized in the study analyses: SAT ERW section, SAT Math section, SAT Total scores, SAT tilt, as well as HSGPA, FYGPA, and SYCGPA. Retention rates to the third year are also reported. [5] Descriptive statistics for students broken out by Context Quintiles are reported in Table A1.

Table 4: Descriptive Statistics for Measures of Interest

	Study Sample (*n* = 54,924)				**2017 Graduating Seniors who took the SAT (*N* = 1,715,481)**			
Measure	***M***	***SD***	***Min***	***Max***	***M***	***SD***	***Min***	***Max***
SAT ERW	606	79	200	800	533	100	200	800
SAT Math	604	90	200	800	527	107	200	800
SAT Total	1210	157	400	1600	1060	195	400	1600
SAT Tilt	0.00	0.63	-3.10	3.60	1.33	0.68	-5.70	5.62
HSGPA	3.73	0.44	1.33	4.33	3.33	0.65	0.00	4.33
FYGPA	3.21	0.59	0.07	4.30				
Second-Year Cumulative GPA	3.20	0.58	0.05	4.16				
Retention to Year 3	0.92	0.27	0.00	1.00				
Note. Not all 2017 graduating seniors who took the SAT reported their HSGPA (*n* = 1,594,136).								

Table 5 contains the descriptive statistics for each of the 13 academic majors included in the study. As noted above, the sample consists of students who enrolled in four-year post-secondary institutions, and these students tend to have higher mean HSGPAs and SAT scores than students in the national population. Across the 13 academic majors, mean SAT ERW scores ranged 574 to 643; mean SAT Math scores ranged from 562 to 682; mean SAT Total scores ranged from 1140 to 1321; mean SAT tilt ranged from -0.47 to 0.42; mean HSGPA ranged from 3.58 to 3.89; mean FYGPA ranged from 3.07 to 3.31; SYCGPA ranged from 3.05 to 3.33; and third year retention rates ranged from 89% to 94%.

STEM and Non-STEM Categories

Interest in science, technology, engineering, and math (STEM) led to a decision to group academic majors into two categories: STEM and Non-STEM. Biological and biomedical sciences; computer and information sciences and support services; engineering; mathematics and statistics; and physical sciences were categorized as STEM. Business, management, marketing, and related support services; communication, journalism, and related programs; education; English language and literature/ letters;

[5] As noted earlier, retention to the second year was required for inclusion in the study, so the retention rate to year two was 100%.

health professions and related programs; liberal arts and sciences, general studies, and humanities; psychology; and social sciences were categorized as non-STEM.

To put some of the descriptive statistics in context, we plotted the means for the thirteen academic majors as well as the overall sample. STEM majors are in dark blue; non-STEM majors are in light blue, and the overall sample is in red. In Figure 1, SAT Total score is on the X axis, and HSGPA is on the Y axis. STEM majors had the five highest mean SAT Total scores and five of the six highest mean HSGPAs.

Table 5: Descriptive Statistics by Academic Major

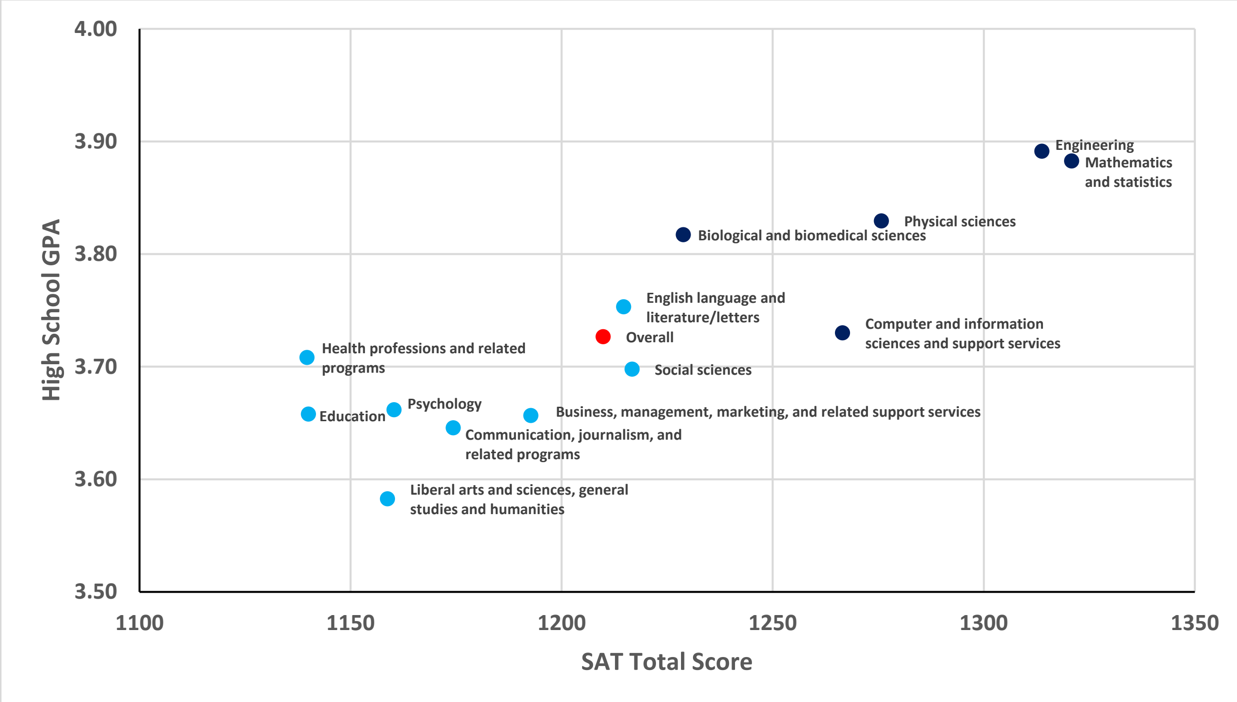
Academic Major	Biological and biomedical sciences (*k*=60, *n*=8,034)				Business, management, marketing, and related support services (*k*=58, *n*=10,064)				Communication, journalism, and related programs (*k*=37, *n*=2,201)				Computer and information sciences and support services (*k*=34, *n*=2,403)				Education (*k*=39, *n*=2,307)			
Measure	***Mean***	***SD***	***Min***	***Max***	***Mean***	***SD***	***Min***	***Max***	***Mean***	***SD***	***Min***	***Max***	***Mean***	***SD***	***Min***	***Max***	***Mean***	***SD***	***Min***	***Max***
SAT ERW	616	77	200	800	595	76	300	800	604	75	360	800	624	79	310	800	578	76	330	790
SAT Math	613	85	200	800	598	84	230	800	570	78	310	800	642	88	320	800	562	78	310	800
SAT Total	1229	150	400	1590	1193	147	560	1580	1174	140	700	1570	1267	155	630	1600	1140	140	700	1540
SAT Tilt	-0.01	0.60	-2.07	2.87	0.06	0.61	-2.64	2.74	-0.30	0.60	-2.33	2.14	0.18	0.62	-1.67	3.07	-0.11	0.62	-2.20	1.88
HSGPA	3.82	0.40	1.33	4.33	3.66	0.46	1.67	4.33	3.65	0.46	1.67	4.33	3.73	0.44	1.67	4.33	3.66	0.46	1.33	4.33
FYGPA	3.22	0.59	0.07	4.21	3.24	0.57	0.19	4.19	3.25	0.56	0.59	4.27	3.18	0.60	0.50	4.15	3.31	0.55	0.45	4.10
SYCGPA	3.21	0.58	0.05	4.08	3.21	0.56	0.13	4.00	3.25	0.54	0.87	4.00	3.16	0.60	0.59	4.11	3.33	0.56	0.23	4.00
Ret. 3	0.93	0.25	0.00	1.00	0.93	0.25	0.00	1.00	0.94	0.24	0.00	1.00	0.92	0.27	0.00	1.00	0.93	0.25	0.00	1.00

Academic Major	Engineering (*k*=33, *n*=7,422)				English language and literature/ letters (k=26, n=802)				Health professions and related programs (k=49, n=6,267)				Liberal arts and sciences, general studies, and humanities (k=37, n=5,189)				Mathematics and statistics (k=20, n=761)			
Measure	***Mean***	***SD***	***Min***	***Max***	***Mean***	***SD***	***Min***	***Max***	***Mean***	***SD***	***Min***	***Max***	***Mean***	***SD***	***Min***	***Max***	***Mean***	***SD***	***Min***	***Max***
SAT ERW	643	71	280	800	633	66	400	780	574	75	330	790	583	79	200	800	639	74	360	790
SAT Math	671	74	340	800	582	72	350	790	565	81	290	800	575	86	280	800	682	75	430	800
SAT Total	1314	134	630	1600	1215	124	770	1530	1140	144	690	1570	1159	153	680	1580	1321	135	850	1590
SAT Tilt	0.27	0.56	-1.99	3.60	-0.47	0.57	-2.34	1.22	-0.04	0.60	-2.38	2.59	-0.04	0.63	-2.35	2.95	0.42	0.62	-1.39	2.84
HSGPA	3.89	0.36	2.00	4.33	3.75	0.42	2.00	4.33	3.71	0.44	1.33	4.33	3.58	0.48	1.33	4.33	3.88	0.38	2.00	4.33
FYGPA	3.19	0.58	0.20	4.13	3.30	0.51	1.43	4.00	3.28	0.57	0.38	4.30	3.07	0.64	0.13	4.27	3.29	0.55	0.85	4.08
SYCGPA	3.16	0.57	0.44	4.12	3.31	0.51	0.79	4.00	3.26	0.55	0.33	4.00	3.05	0.63	0.25	4.16	3.26	0.53	1.23	4.10
Ret. 3	0.93	0.26	0.00	1.00	0.94	0.24	0.00	1.00	0.89	0.31	0.00	1.00	0.89	0.31	0.00	1.00	0.94	0.23	0.00	1.00

Academic Major	Physical sciences (k=34, n=1,518)				Psychology (k=50, n=3,299)				Social sciences (k=53, n=4,657)			
Measure	***Mean***	***SD***	***Min***	***Max***	***Mean***	***SD***	***Min***	***Max***	***Mean***	***SD***	***Min***	***Max***
SAT ERW	632	77	330	800	592	80	370	790	619	80	330	800
SAT Math	644	83	380	800	568	84	320	800	598	88	210	800
SAT Total	1276	147	770	1590	1160	151	710	1540	1217	155	590	1600
SAT Tilt	0.12	0.62	-1.75	2.90	-0.19	0.62	-2.34	3.15	-0.18	0.62	-3.10	2.64
HSGPA	3.83	0.40	2.33	4.33	3.66	0.46	1.67	4.33	3.70	0.44	1.67	4.33
FYGPA	3.17	0.61	0.07	4.11	3.16	0.58	0.36	4.09	3.20	0.58	0.22	4.10
SYCGPA	3.15	0.60	0.53	4.09	3.17	0.59	0.37	4.04	3.23	0.55	0.13	4.09
Ret. 3	0.92	0.27	0.00	1.00	0.92	0.27	0.00	1.00	0.93	0.25	0.00	1.00

Note. *SD*=standard deviation; *k*=number of institutions; *n*=number of students; ERW=Evidence-based Reading and Writing; HSGPA=high school grade point average; FYGPA=first-year grade point average; SYCGPA=second-year cumulative grade point average; Ret. 3= third-year retention rate.

Figure 1: SAT Total Score and HSGPA by Academic Major



In Figure 2, SAT ERW section score is on the X axis and SAT Math section score is on the Y axis. Students majoring in mathematics and statistics and in engineering had the highest mean SAT ERW and SAT Math section scores. STEM majors had the five highest mean SAT Math section scores and five of the seven highest mean SAT ERW section scores.

Figure 2: SAT ERW Score and SAT Math Score by Academic Major

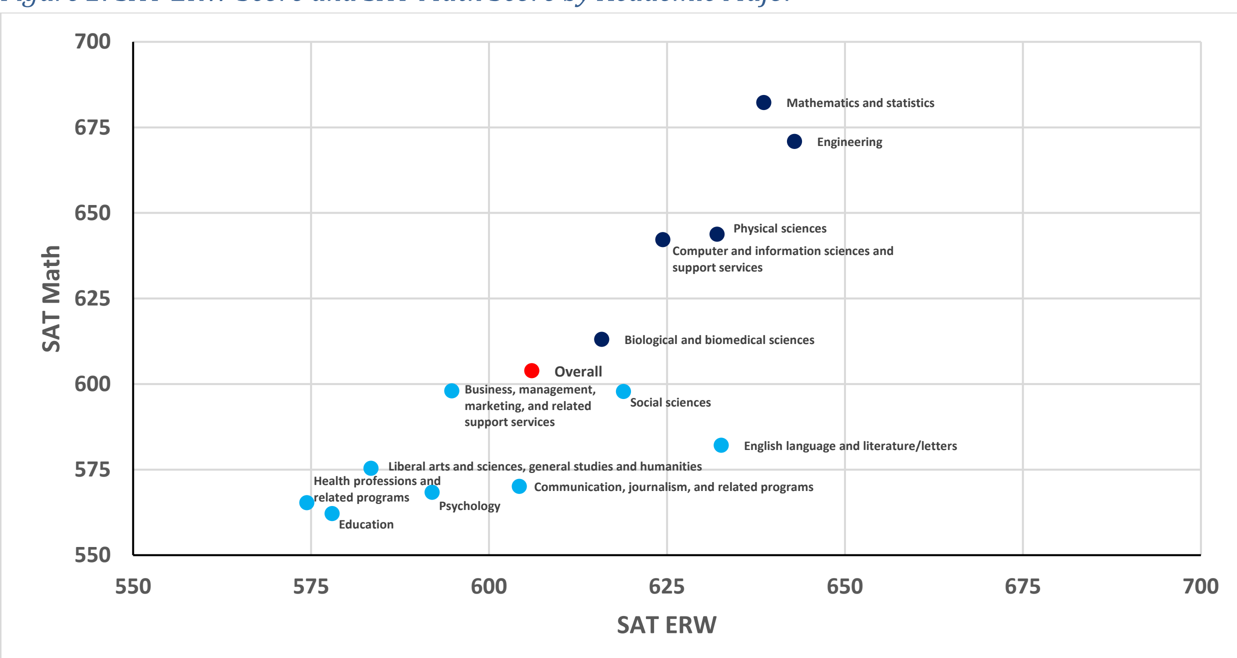
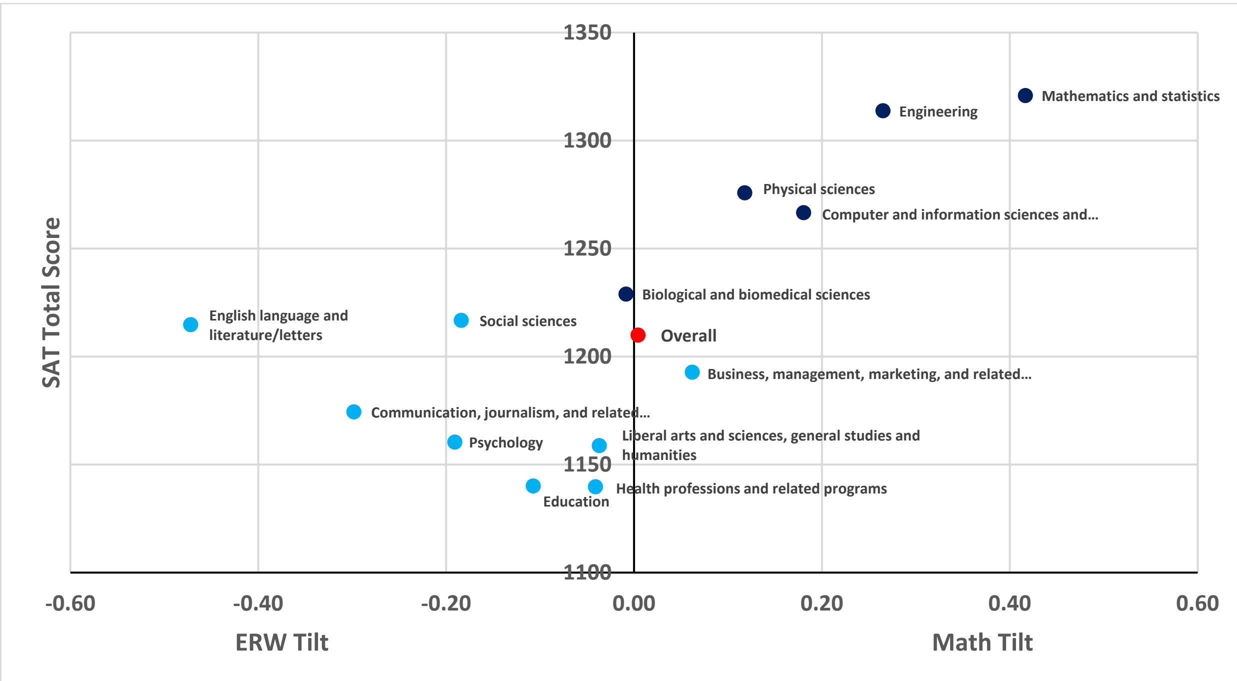


Figure 3 highlights the distribution of mean SAT tilt and mean SAT Total score across the 13 academic majors. As seen in Figure 1, the five STEM majors have the highest mean SAT Total scores, and we can also see that four of the five have mean SAT tilts toward Math. For the Non-STEM majors, seven of the eight have mean SAT tilts toward ERW. The greatest amount of mean Math tilt was found among students majoring in mathematics and statistics, and the greatest amount of ERW tilt was found among students majoring in English language and literature/letters.

Figure 3: SAT Total Score and SAT Tilt by Academic Major



Figures 1 through 3 show that students who had declared STEM majors by the end of their second year of college had, on average, the highest levels of precollege academic achievement as measured by the SAT and HSGPA. The general trend was that the academic majors with higher mean SAT Total scores also had higher mean HSGPAs (Figure 1), and the academic majors with higher mean ERW section scores had higher mean Math section scores. However, when looking at mean SYCGPA, higher mean SAT Total scores and HSGPAs were not necessarily associated with higher mean SYCGPAs after controlling for academic major. In fact, the non-STEM majors tended to have the highest mean SYCGPAs despite having lower mean SAT Total scores and HSGPAs. Figures 4 and 5 show the plots for mean SAT Total scores and HSGPA, respectively, and SYCGPA for the 13 academic majors and the overall sample.

Figure 4: SAT Total Score and Second-Year Cumulative GPA by Academic Major

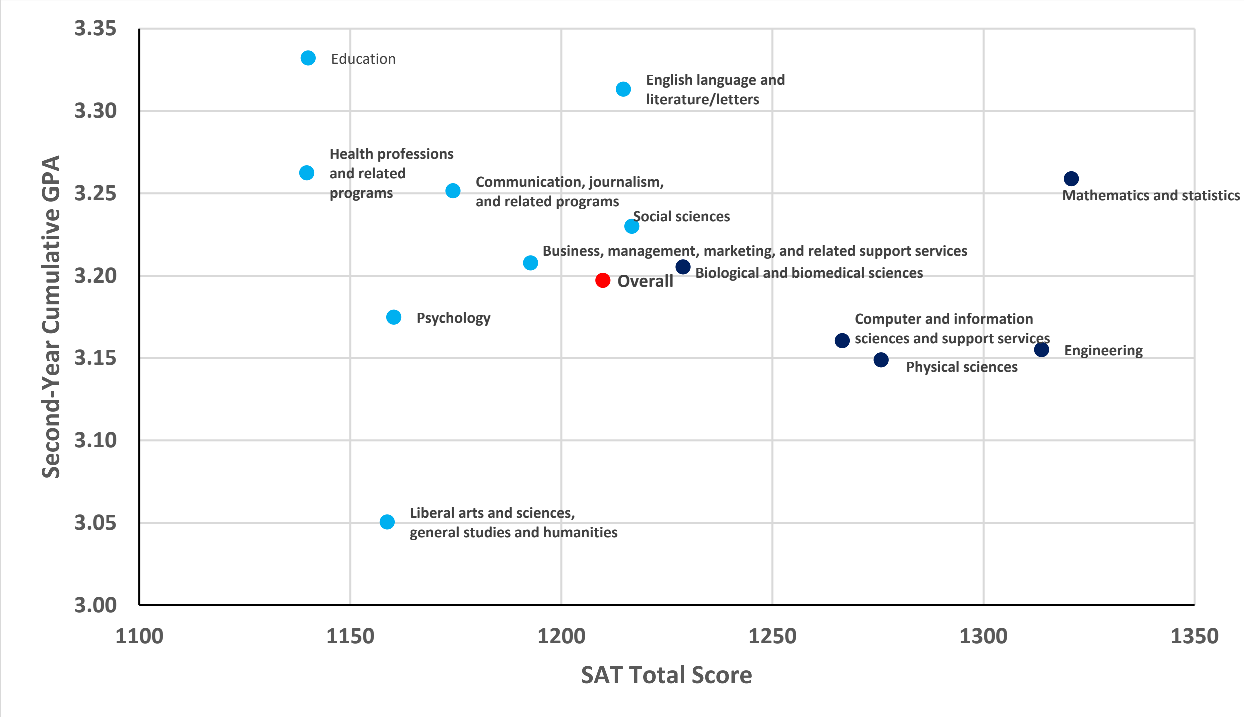
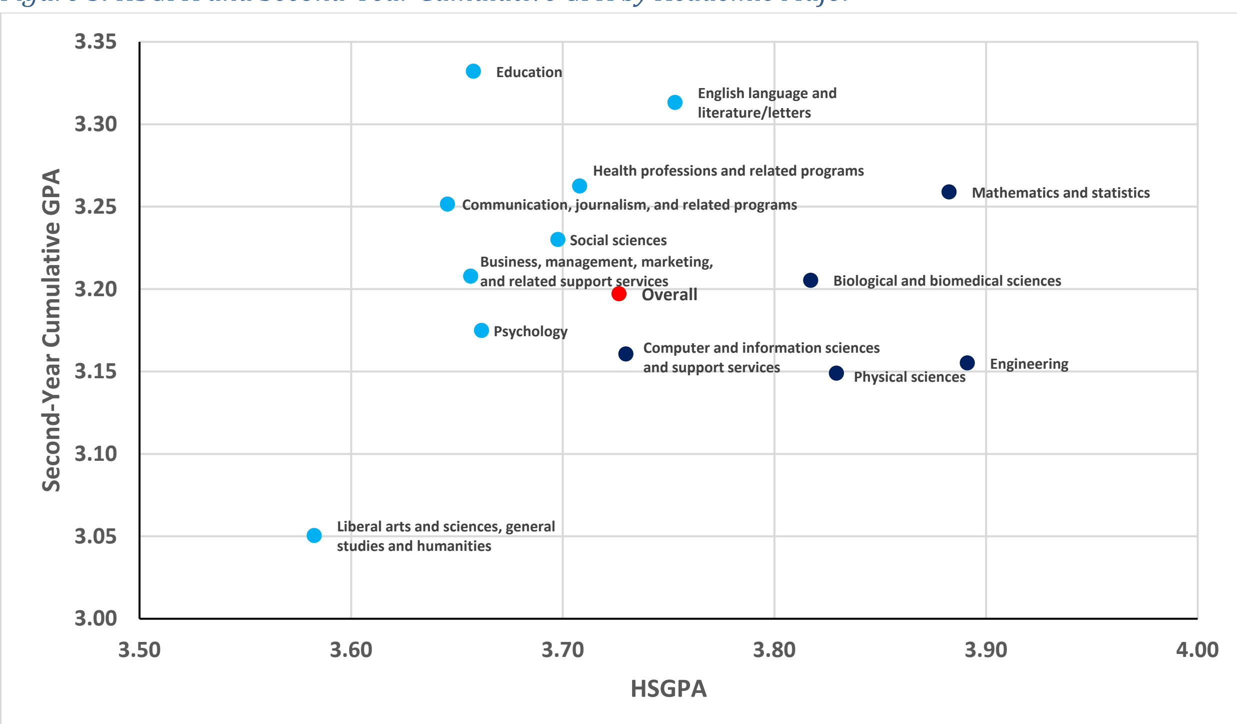


Figure 5: HSGPA and Second-Year Cumulative GPA by Academic Major



Figures 1 through 5 highlight the differences across academic majors regarding their students' performances on precollege academic measures—the SAT and HSGPA—and the average grades these students earned through their first two years of college. Although there is some degree of overlap in the courses taken by students regardless of their academic majors, students in different programs of study are on different tracks and often take very different courses despite being at the same institution. As mentioned earlier, past research has found that grading standards vary across courses, and these differences manifest themselves in differences in undergraduate GPA. While it is often assumed that GPA is a common criterion, in reality it is a multitude of criteria that is often unique to each student. As noted in the literature review, many researchers have made adjustments to student GPAs to account for differences in the courses students completed in college, but these adjustments are exceedingly complex. A more manageable solution is to conduct analyses at the academic major level, where—even though students still have a degree of latitude which courses they take—there are more courses in common within academic majors at an institution than is found when students of all academic majors at an institution are lumped together in overall analyses.

Methods

Correlational Analyses

Correlations were computed between SAT scores (both section scores) and SYCGPA as well as HSGPA and SYCGPA for all academic majors. The incremental validity of the SAT over HSGPA alone was also evaluated for each academic major. All correlational analyses were conducted at the institution level and then weighted by the institutional sample size and pooled together for the entire sample. For correlations to be run for an academic major at an institution, there had to be at least 15 students within that academic major. If that was not the case, the institution was removed from that specific academic major analysis. Correlations were corrected for multivariate range restriction (Lawley, 1943) using the 2017 graduating seniors who took the SAT as the reference population. For reference, correlations with absolute values of .50 or higher are considered to be large, correlations with absolute values less than .50 and greater than or equal to .30 are considered to be medium, and correlations with absolute values less than .30 but greater than or equal to .10 are considered to be small (Cohen, 1988).

After aggregating the institutional results for each academic major level, we aggregated the results from the 13 academic major analyses to obtain the average SAT and HSGPA correlations with SYCGPA after accounting for differences in course taking and grading standards across academic majors. [6] We also did this for the five STEM majors and for eight non-STEM majors.

Finally, we ignored academic majors and calculated the average SAT and HSGPA correlations with SYCGPA at the institution level before aggregating across institutions. This approach is common in validity studies examining FYGPA. This approach did not control for differences in course taking and

[6] This approach is sometimes called a second-order meta-analysis (Schmidt & Hunter, 2015). For each academic major, analyses were conducted at the institution level and then aggregated. This aggregation of the results of the institution-level analyses is considered a first-order meta-analyses, so we had 13 first-order meta-analyses. A second-order meta-analysis is the aggregation of the results of the first-order meta-analyses.

grading standards across academic majors, and it allowed us to determine the increase (or decrease) in the amount of variance in SYCGPA explained by the SAT and HSGPA when considering differences across academic majors.

Logistic Regression Analyses

Logistic regression analyses were employed for predicting students' probabilities of earning a SYCGPA of 3.00 or higher. This criterion was selected as a reasonable threshold for indicating that students are performing well in their college-level work through the end of the second year of college.[7] In the overall sample, 69% of the students earned a SYCGPA of 3.0 or higher, and a SYCGPA of 3.0 was below the average in every academic major in the study (see Table 5). To estimate the probability of earning a SYCGPA of 3.00 or higher, logistic regression analyses were conducted at each institution. The institution-level coefficients were weighted by the number of students in the institutional study, and then mean coefficients from the aggregated weights were calculated.

Subgroup Analyses

In addition to the traditional correlational and logistic regression approaches to examining relationships between precollege academic achievement measures—the SAT and HSGPA—and SYCGPA, we also conducted analyses that looked backward in the sense that we used SYCGPA as a starting point and examined the SAT and HSGPA profiles of students who were not performing as well as their peers within their academic majors at their institutions. Within each academic major at each institution, we used students' SYCGPAs to divide them into the top, middle, and bottom third of SYCGPA. We then calculated the mean SAT scores and HSGPAs for these students, with an emphasis on the students in the five STEM majors. We next added students' Landscape information and focused on the students within the five STEM majors who were in Landscape's Context Quintiles 1 (low challenge) and 5 (high challenge). The purpose of these analyses was to identify students in STEM majors who may need academic support in their studies upon entering college.[8]

Results

Correlational Analyses

Table 6 presents the corrected correlations for the SAT ERW section, the SAT Math section, the SAT ERW and SAT Math sections together, HSGPA, and both SAT sections with HSGPA all with SYCGPA. The raw correlations for academic majors (and other groupings) can be found in Table A2. The key findings follow.

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[7] Some may consider a GPA of 2.5 or higher as a sufficient threshold, and this threshold has been used in previous College Board research that examined FYGPA and second-year retention (e.g., Westrick et al., 2019). However, in the current study, all students within many of the majors analyzed across multiple institutions (who were all retained through the end of the second year) earned a SYCGPA of 2.5 or higher, making this SYCGPA threshold impractical.

[8] Analyses were also conducted for students broken out by urbanicity, race/ethnicity, and highest level of parental education.

Table 6: Corrected Correlations of Predictors with Second-Year Cumulative GPA by Academic Major

Academic Major or Grouping	***k***	***n***	**ERW**	**Math**	**SAT**	**HSGPA**	**SAT+HSGPA**	**IV**
Biological and biomedical sciences	60	8,034	.60	.62	.65	.62	.74	.12
Business, management, marketing, and related support services	58	10,064	.56	.56	.60	.62	.70	.08
Communication, journalism, and related programs	37	2,201	.57	.54	.61	.64	.74	.10
Computer and information sciences and support services	34	2,403	.52	.55	.58	.59	.68	.09
Education	39	2,307	.51	.49	.55	.56	.67	.11
Engineering	33	7,422	.61	.67	.68	.64	.77	.13
English language and literature/letters	26	802	.58	.56	.64	.60	.74	.14
Health professions and related programs	49	6,267	.55	.56	.60	.61	.70	.09
Liberal arts and sciences, general studies, and humanities	37	5,189	.45	.41	.48	.56	.62	.06
Mathematics and statistics	20	761	.58	.57	.62	.66	.75	.09
Physical sciences	34	1,518	.60	.61	.66	.63	.75	.12
Psychology	50	3,299	.55	.55	.60	.55	.68	.13
Social sciences	53	4,657	.58	.53	.60	.57	.69	.12
Weighted Average across 5 STEM Majors	60	20,138	.59	.63	.66	.63	.74	.11
Weighted Average across 8 Non-STEM Majors	72	34,786	.54	.53	.58	.59	.68	.09
Weighted Average across 13 Majors	73	54,924	.56	.56	.61	.61	.71	.10
Overall (ignoring students' academic majors)	73	54,924	.53	.51	.55	.59	.66	.07

Note. *k*=number of institutions; *n*=number of students; ERW=Evidence-based Reading and Writing; HSGPA=high school grade point average; IV=incremental validity.

First, the SAT was a stronger predictor of SYCGPA than HSGPA in six of the 13 academic majors and in three of the five STEM majors. After weighting and aggregating across the five STEM majors, the weighted average correlation between the SAT and SYCGPA was .66 versus .63 for average correlation between HSGPA and SYCGPA. Across the eight non-STEM majors, the mean SAT and mean HSGPA correlations with SYCGPA were .58 and .59, respectively. Across the 13 academic majors, both the weighted mean SAT and HSGPA correlations with SYCGPA were .61. In contrast, when the differences in courses and grading standards across academic majors were ignored at the institution level (k=73) and correlations were calculated for all students within institutions, the mean SAT and mean HSGPA correlations with SYCGPA were .55 and .59, respectively. Regardless of the approach taken, these are large correlations (Cohen, 1988) that show strong SAT-SYCGPA and HSGPA-SYCGPA relationships.

Second, the SAT added incremental validity beyond that of HSGPA alone for all 13 academic majors. That is, the joint use of the SAT and HSGPA was better than using HSGPA alone to predict SYCGPA. The SAT plus HSGPA correlations with SYCGPA ranged from.62 to.77, and the incremental validity of the SAT beyond that of HSGPA ranged from .06 (Liberal arts and sciences, general studies, and humanities) to .14 (English language and literature/letters). When using the weighted averages for the five STEM and eight non-STEM majors, the SAT plus HSGPA correlations with SYCGPA were .74 and .68, respectively, and the incremental validities of the SAT beyond HSGPA were .11 and .09, respectively. Across the 13 academic majors, the weighted average SAT plus HSGPA correlation with SYCGPA was .71, and the incremental validity of the SAT beyond that of HSGPA alone was .10. In contrast, when ignoring the differences in courses and grading standards across academic majors, the SAT plus HSGPA correlation with SYCGPA was .66, and the incremental validity of the SAT beyond that of HSGPA was .07. This finding suggests that most validity research, which does not account for students' academic majors, underestimates the validity of the SAT and the incremental validity of the SAT above HSGPA.

Logistic Regression Analyses

Results of the logistic regression analyses conducted to predict students' probabilities of earning a SYCGPA of 3.00 or higher in the 13 academic majors are presented in Figures 6 through 18. The solid lines represent the estimated probabilities given both HSGPA and SAT Total score. The orange dashed line represents the estimated probability of success when using HSGPA alone. When SAT scores and HSGPA are used jointly in a compensatory model, students' chances of success vary depending on their SAT scores and HSGPAs. For students with the same SAT score and different HSGPAs, their probabilities of success will vary according to their HSGPAs. For students with the same HSGPA and different SAT scores, their probabilities of success will vary according to their SAT scores. However, when HSGPA is used alone, there is only one estimated probability of success. For example, in Figure 6 (Biological and biomedical sciences), when using HSGPA alone, students with a HSGPA of 4.0 have a 79% chance of earning a SYCGPA of 3.0 or higher. However, for students with a HSGPA of 4.0 and SAT Total scores of 1000, 1200, and 1400, their chances of earning a SYCGPA of 3.0 or higher are 48%, 76% and 91%, respectively. This clearly indicates that not all HSGPAs hold the same meaning and that SAT scores further contextualize HSGPA for improved use on campus. Figure 19 presents students' probabilities of earning a SYCGPA of 3.00 or higher based on an overall analysis that ignored students' academic majors.

Figure 6: Chance of Earning a SYCGPA of 3.00 or Higher, given SAT and HSGPA; Biological and Biomedical Sciences

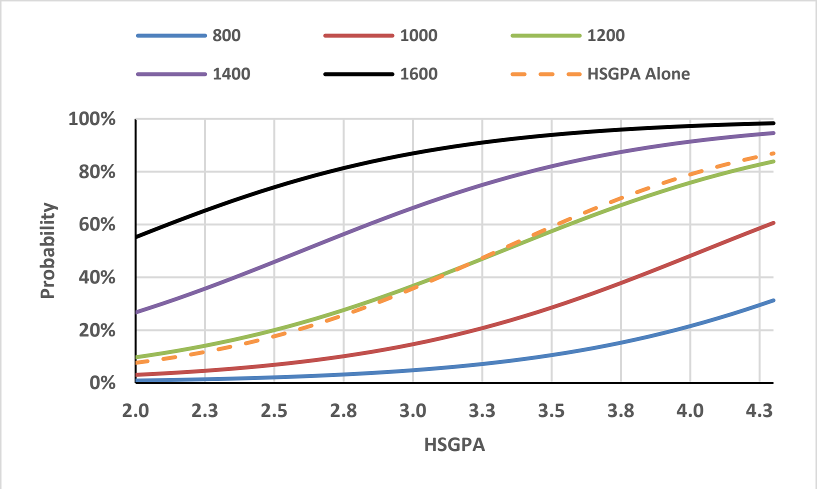


Figure 7: Chance of Earning a SYCGPA of 3.00 or Higher, given SAT and HSGPA; Business, Management, Marketing, and Related Support Services

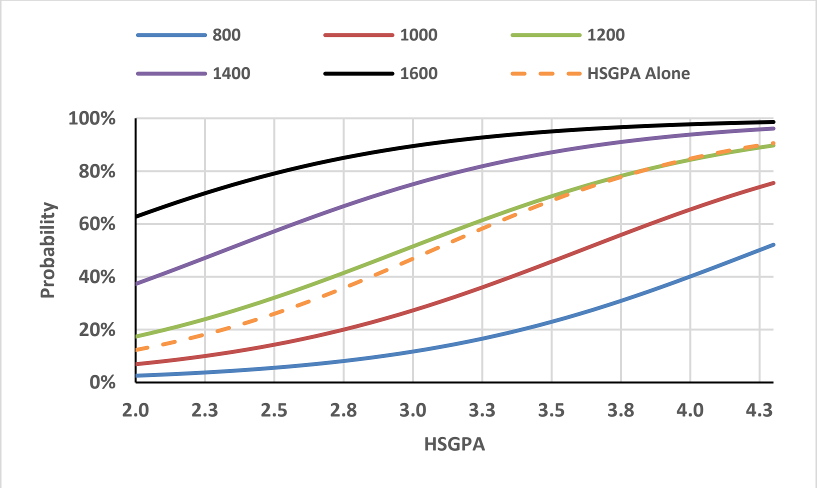


Figure 8: Chance of Earning a SYCGPA of 3.00 or Higher, given SAT and HSGPA; Communication, Journalism, and Related Programs

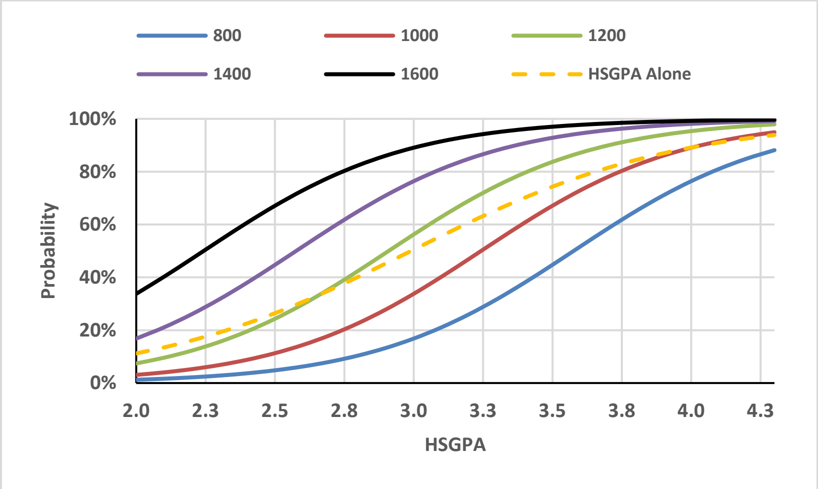


Figure 9: Chance of Earning a SYCGPA of 3.00 or Higher, given SAT and HSGPA; Computer and Information Sciences and Support Services

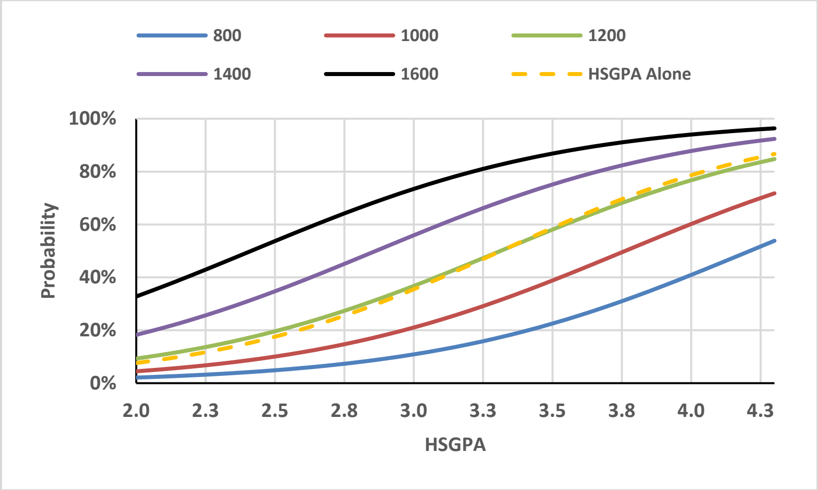


Figure 10: Chance of Earning a SYCGPA of 3.00 or Higher, given SAT and HSGPA; Education

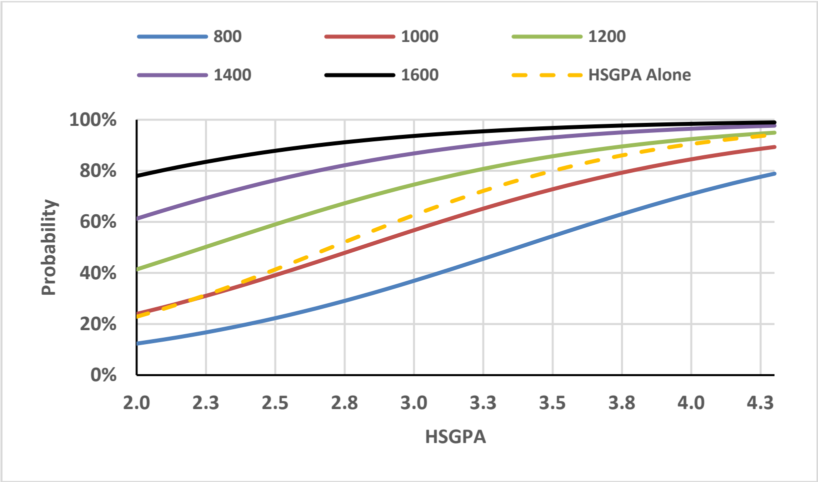


Figure 11: Chance of Earning a SYCGPA of 3.00 or Higher, given SAT and HSGPA; Engineering

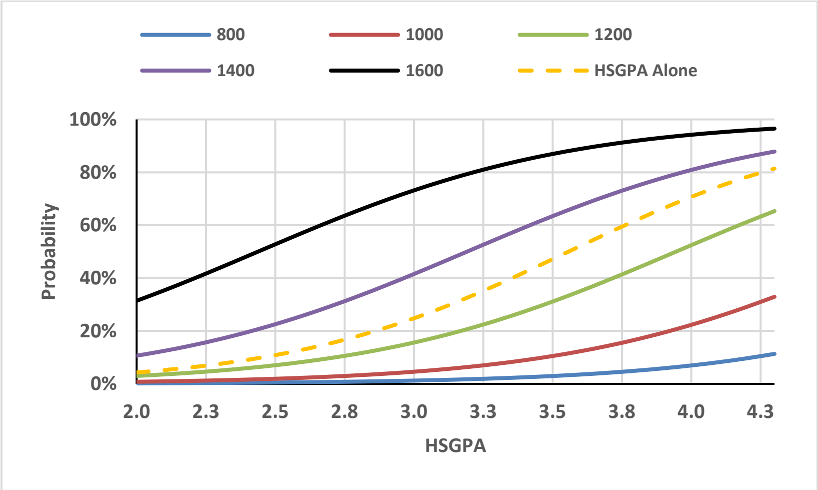


Figure 12: Chance of Earning a SYCGPA of 3.00 or Higher, given SAT and HSGPA; English Language and Literature/Letters

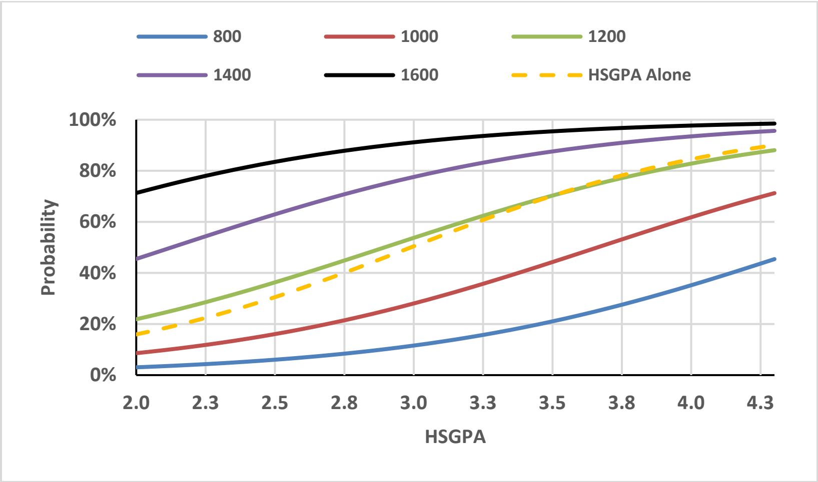


Figure 13: Chance of Earning a SYCGPA of 3.00 or Higher, given SAT and HSGPA; Health Professions and Related Programs

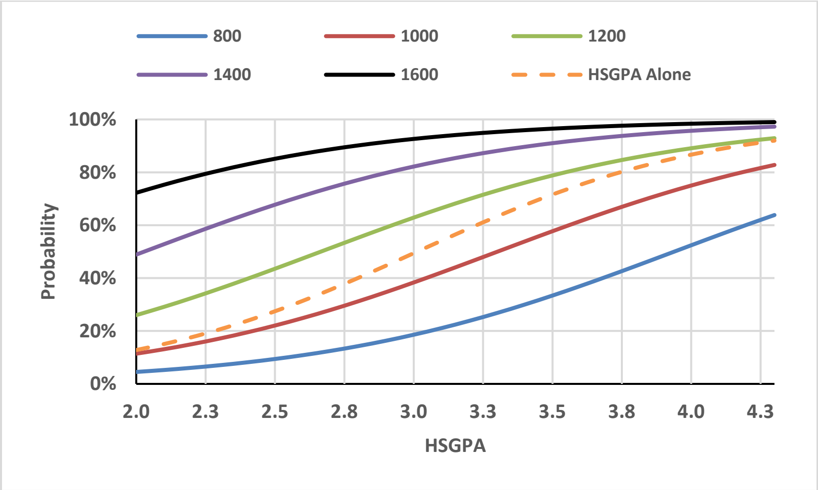


Figure 14: Chance of Earning a SYCGPA of 3.00 or Higher, given SAT and HSGPA; Liberal Arts and Sciences, General Studies, and Humanities

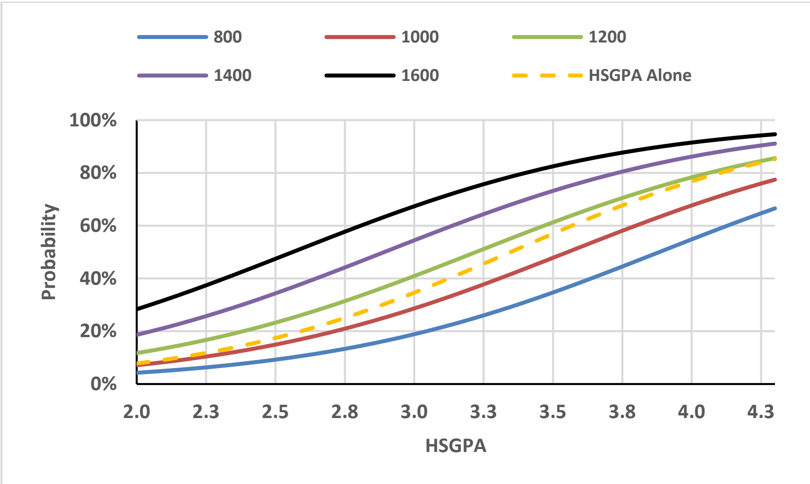


Figure 15: Chance of Earning a SYCGPA of 3.00 or Higher, given SAT and HSGPA; Mathematics and Statistics

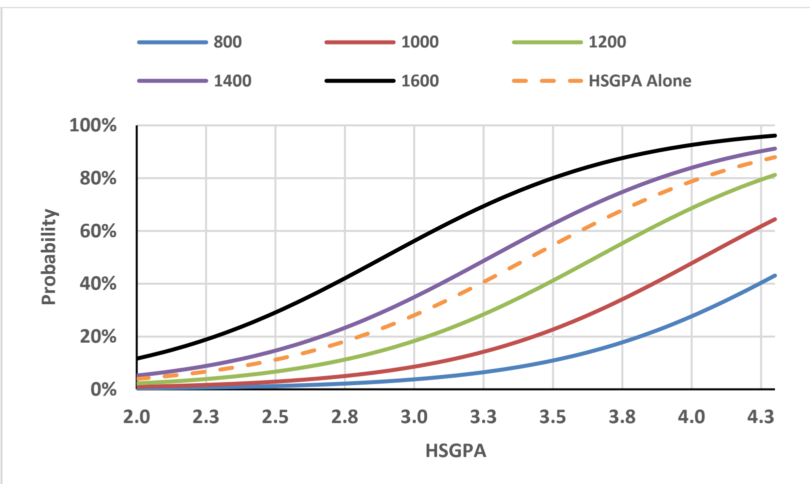


Figure 16: Chance of Earning a SYCGPA of 3.00 or Higher, given SAT and HSGPA; Physical Sciences

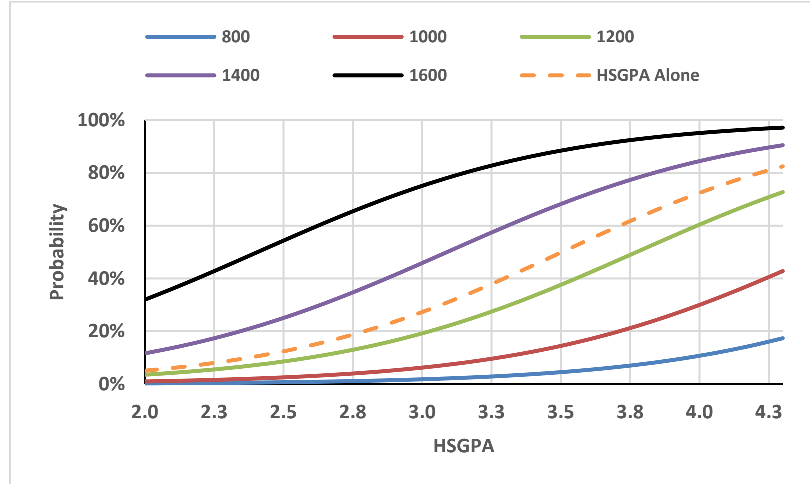


Figure 17: Chance of Earning a SYCGPA of 3.00 or Higher, given SAT and HSGPA; Psychology

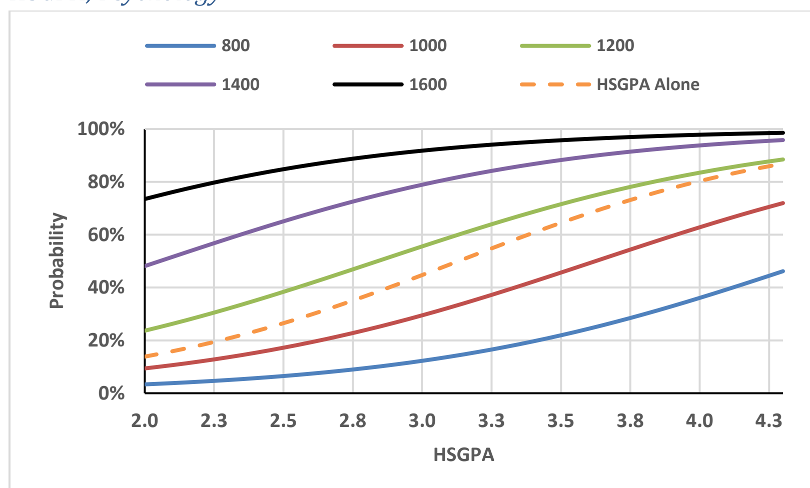


Figure 18: Chance of Earning a SYCGPA of 3.00 or Higher, given SAT and HSGPA; Social Sciences

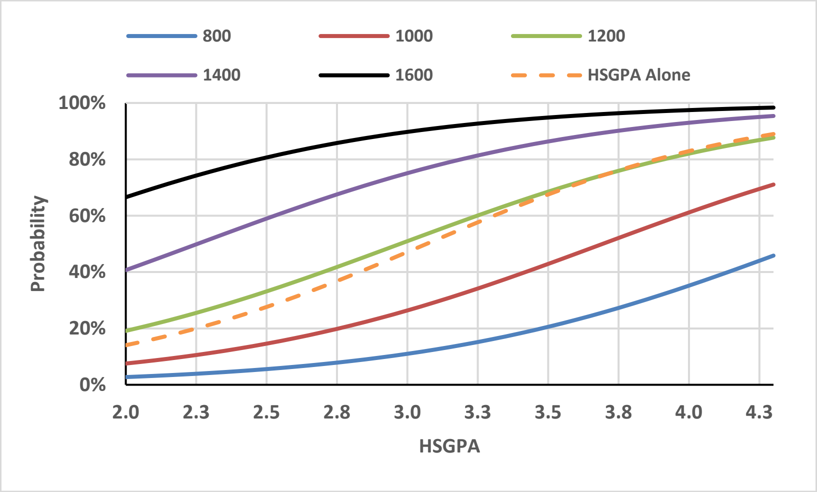


Figure 19: Chance of Earning a SYCGPA of 3.00 or Higher, given SAT and HSGPA; Overall

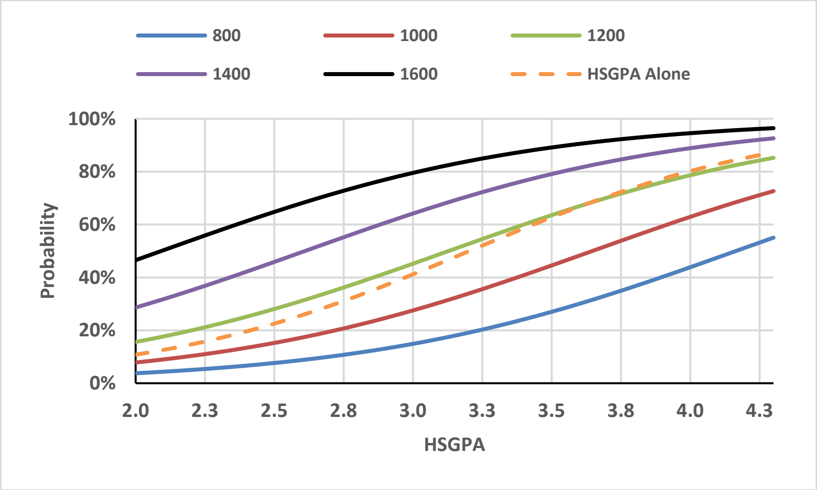


Table 7: Chance of Earning a SYCGPA of 3.0 or Higher given a HSGPA of 3.7 and an SAT Total Score of 1200

Academic Major	Chance
Communication, journalism, and related programs	90%
Education	89%
Health professions and related programs	84%
Psychology	77%
Business, management, marketing, and related support services	77%
English language and literature/letters	76%
Social sciences	75%
Liberal arts and sciences, general studies, and humanities	69%
Computer and information sciences and support services	66%
Biological and biomedical sciences	65%
Mathematics and statistics	53%
Physical sciences	47%
Engineering	39%
Overall (ignoring academic major)	70%

As illustrated by Figures 6 through 18, students' chances of earning a SYCGPA of 3.0 or higher varies not only by their SAT scores and HSGPAs, but also by their academic major. Table 7 provides students chances of earning a SYCGPA of 3.0 or higher given a HSGPA of 3.7 (study sample mean = 3.73) and an SAT Total score of 1200 (study sample mean = 1210). As shown in Table 7, students with the same precollege academic achievement levels have very different chances of earning a SYCGPA of 3.0 or higher across the 13 majors, ranging from a low of 39% (Engineering) to a high of 90% (Communication, journalism, and related programs). Keep in mind that these are aggregate results across institutions. Probabilities of success within academic majors vary across institutions, and probabilities of success vary across academic majors within institutions. Each institution is unique, as are the academic programs offered at institutions, and students' probabilities of academic success will vary depending on the institution they attend and their chosen academic major, but these graphs provide some stable patterns and trends worth noting.

Subgroup Analyses

Controlling for differences across institutions by including only institutions that had all 13 academic majors would have excluded the vast majority of institutions. To maximize the number of institutions, we aggregated students into STEM and non-STEM majors. As we also wanted to examine performance differences across Context Quintiles, we further required that each institution had at least 15 students in Context Quintiles 1 (low challenge) and 5 (high challenge) in both the STEM and non-STEM groupings. This left us with 20 institutions for logistic regression analyses to predict students' chances of earning a SYCGPA of 3.0 or higher. Descriptive statistics for these students are reported in Table A3.

Figures 20 and 21 show the results for STEM students in Context Quintiles 1 and 5, respectively. Two trends stood out. First, as seen in the figures for individual academic majors, using SAT scores with HSGPA provides vastly more information about students' chances of success than does using HSGPA alone. When using HSGPA alone, STEM students with a HSGPA of 3.7 in Context Quintile 1 (low challenge) had a 69% chance of earning a SYCGPA of 3.0 or higher. However, when SAT scores are included, the chances of earning a SYCGPA of 3.0 or higher for students with a HSGPA of 3.7 and an SAT Total scores of 800, 1000, 1200, 1400, and 1600 were 16%, 32%, 55%, 76%, and 89%, respectively. STEM students in Context Quintile 5 (high challenge) with a HSGPA of 3.7 had a 38% chance of earning a SYCGPA of 3.0 or higher. When SAT scores were included, students' chances of earning a SYCGPA of 3.0 or higher with a HSGPA of 3.7 and an SAT Total scores of 800, 1000, 1200, 1400, and 1600 were 15%, 28%, 46%, 65%, and 81%, respectively. Despite having the same HSGPA (3.7), students' probabilities of success differed dramatically depending upon their SAT scores, with probabilities of earning a SYGPA of 3.0 or higher increasing as SAT scores increased.

Figure 20: Chance of Earning a SYCGPA of 3.00 or Higher, given SAT and HSGPA, for STEM Students in Context Quintile 1

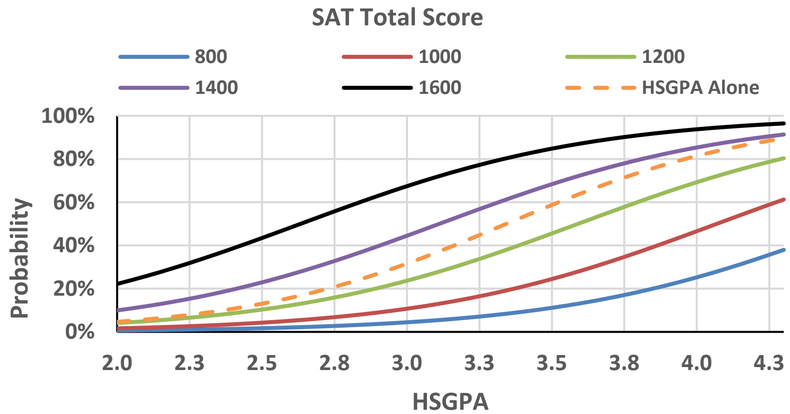


Figure 22: Chance of Earning a SYCGPA of 3.00 or Higher, given SAT and HSGPA, for Non-STEM Students in Context Quintile 1

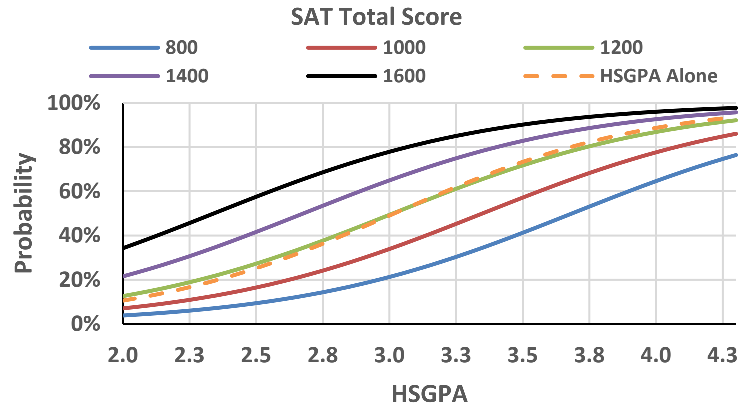


Figure 21: Chance of Earning a SYCGPA of 3.00 or Higher, given SAT and HSGPA, for STEM Students in Context Quintile 5

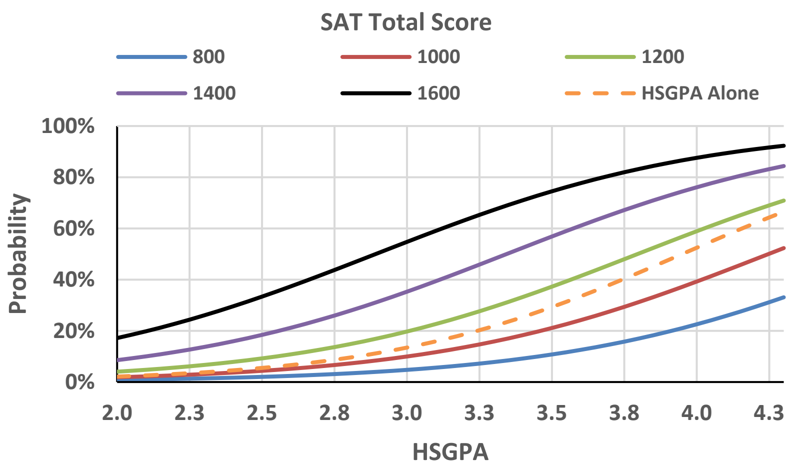
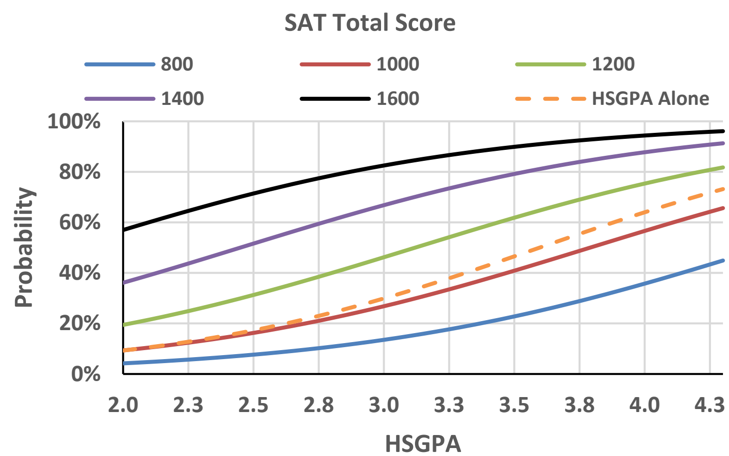


Figure 23: Chance of Earning a SYCGPA of 3.00 or Higher, given SAT and HSGPA, for Non-STEM Students in Context Quintile 5



The second trend was that adding environmental context information tells us that students from educationally disadvantaged environments have lower probabilities of earning a SYCGPA of 3.0 than do students from educationally advantaged environments, even when they have the same HSGPAs and SAT scores. This indicates that precollege environmental challenges moderate the HSGPA and SAT relationship with SYCGPA. As noted above, when using HSGPA alone to predict students' chances of earning a SYGPA of 3.0 or higher, students with a HSGPA of 3.7 in Context Quintile 1 (low challenge) had a 69% chance of earning a SYCGPA of 3.0 or higher, but students in Context Quintile 5 (high challenge) had only a 38% chance of earning a SYCGPA of 3.0 or higher despite having the same HSGPA (3.7), a 31-percentage point gap in predicted success. However, the inclusion of SAT scores dramatically reduces the gap in predicted success. For students in Context Quintiles 1 and 5 with HSGPAs of 3.7 and SAT scores of 800, 1000, 1200, 1400, and 1600, the gaps were 1, 4, 9, 11, and 8 percentage points, respectively, vastly smaller than the 31-percentage point gap found when using HSGPA alone.[9] The reason this finding is so important is that as many institutions aim to diversify the students in their STEM departments, they may need to be aware of academic support services that would be helpful to implement to ensure that all students can be successful in those majors and not just students from educationally advantaged environments. In other words, institutions can admit these students with confidence knowing that the students' SAT scores add valuable information to their HSGPAs and the contextual information regarding the environments from which these students came and how they may be expected to perform in college.

Figures 22 and 23 show the results for non-STEM students in Context Quintiles 1 and 5, respectively, and the general trends seen in these figures are the same as those found in Figures 19 and 20. Using SAT scores with HSGPA provides vastly more information about students' chances of success than does using HSGPA alone, and environmental context information tells us that students from educationally-disadvantaged environments have lower probabilities of success than do students from educationally-advantaged environments, even when they have the same HSGPAs and SAT scores. The main difference between the results for the STEM and non-STEM students is that, within Context Quintiles, the non-STEM students tend to have higher chances of earning a SYCGPA of 3.0 or higher than do the STEM students given the same SAT scores and HSGPAs.

Figure 24 shows the mean SAT total scores for the five STEM majors after breaking out students by SYCGPA within each academic major at the institution level. We divided them into the top, middle, and bottom third of SYCGPA. For example, the mean SYGPAs for the top, middle, and bottom terciles for the biological and biomedical sciences majors were 3.73, 3.36, and 2.55 respectively (full descriptive statistics for the five majors are presented in Table A4). The pattern across all five STEM majors was that the mean SAT Total score for the students in the middle SYCGPA group was higher than the mean SAT Total score for the students in the bottom SYCGPA group, and the mean SAT Total score for the students in the top SYCGPA group was higher than the mean SAT Total score for the students in the

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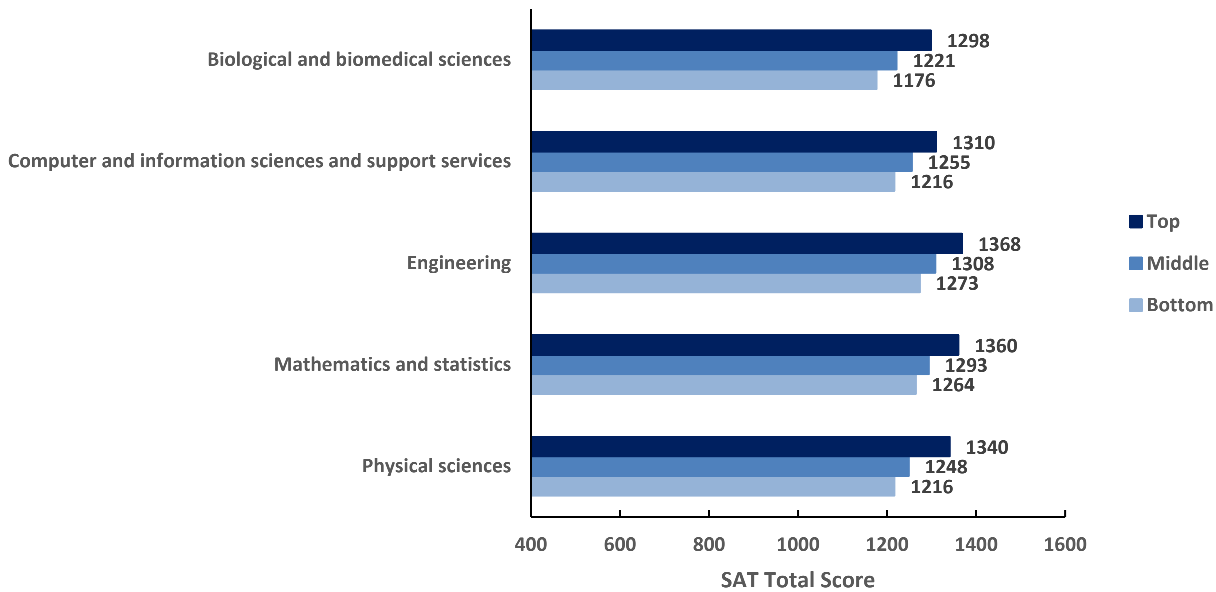
[9] For reference, when environmental context information was not used, STEM students (n=13,883) with a HSGPA of 3.7 had a 61% chance of earning a SYGPA of 3.0 or higher. When including SAT scores of 800, 1000, 1200, 1400, and 1600, the chances of earning a SYCGPA of 3.0 or higher were 12%, 28%, 53%, 76%, and 90%, respectively.

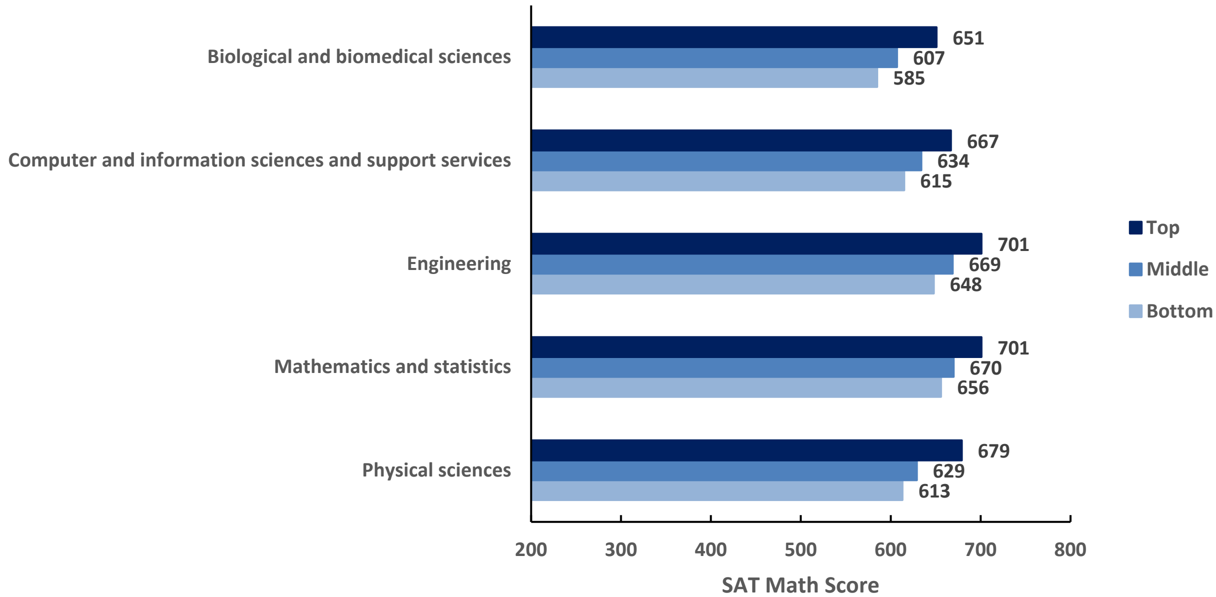
middle SYCGPA group. Across the five academic majors, the differences between the mean SAT total scores for students in the top third and bottom third ranged between 96 and 125 points, approximately half a standard deviation on the normed SAT total score scale (College Board, 2017). Analyses such as this, when conducted within an institution, can help institutions consider whether students with SAT scores in a particular range may benefit from targeted support and instruction to be more successful within specific majors.

Figure 24: Mean SAT Total Score by STEM Major, Disaggregated by Top, Middle, and Bottom Thirds on Second-Year Cumulative GPA



As math coursework is a prominent characteristic of STEM majors, Figure 25 shows the mean SAT Math section scores for the five STEM majors after breaking out students by SYCGPA within each academic major at the institution level. The general pattern is the same as seen for SAT Total scores in Figure 24. Students with higher SAT Math section scores earned, on average, higher SYCGPAs. The differences between the mean SAT Math section scores for students in the top third and bottom third ranged between 43 and 68 points, approximately half a standard deviation on the SAT Math section score scale (College Board, 2017).

Figure 25: Mean SAT Math Score by STEM Major, Disaggregated by Top, Middle, and Bottom Thirds on Second-Year Cumulative GPA



What is noteworthy about the two figures is that the mean SAT Total scores and mean SAT Math section scores for students in the bottom third of SYCGPA within their academic majors at their institutions is that these are strong scores when looking at the national norms. Engineering students in the bottom third of SYCGPA had a mean SAT Total score of 1273. An SAT Total score of 1270 would place a student from the 2017 national cohort at the 83rd SAT User percentile based on the actual scores of students in the graduating class of 2017 who took the new SAT (College Board, 2018). Math and statistics students in the bottom third of SYCGPA had a mean SAT Math section score of 656. An SAT Total score of 660 would place a student from the 2017 national cohort at the 86th SAT User percentile (College Board, 2018). Again, these are strong scores on the national level, but within the context of their academic majors, these scores are reflective of students who are not performing as well as two-thirds of their peers who had even higher SAT scores, on average. These trends can also be seen in SAT ERW section scores and HSGPA in Table A4.

Our final set of results take the preceding analyses a step further by focusing on the STEM students in the bottom third of SYCGPA within their respective academic majors and subdividing them by their Context Quintiles. As in earlier analyses that included environmental context information, we focused here on students in Context Quintiles 1 (low challenge) and 5 (high challenge), and we aggregated the results for the five STEM majors. Descriptive statistics for the STEM students (as well as the five STEM majors) in Context Quintiles 1 through 5 are presented in Table A5.

In Figure 26, we can see that, for STEM students in the bottom third on SYCGPA, students in Context Quintile 1 (low challenge) have mean SAT ERW, Math, and Total scores of 630, 652, and 1282, respectively. For students in Context Quintile 5 (high challenge), their mean SAT ERW, Math, and Total scores were 547, 550, and 1097, respectively. A similar pattern can be seen in Figure 27, as the STEM students in Context Quintile 1 have higher mean HSGPAs, FYGPAs, and SYCGPAs than do the STEM students in Context Quintile 5. Notice that the HSGPA gap between the two groups was only 0.08, but the FYGPA gap was larger at 0.22, and the SYCGPA gap was even larger at 0.30. Also note that the mean SYCGPA for the STEM students in Context Quintile 5 was only 2.34, approximately an average letter grade of C+. Additionally, the retention rate for STEM students in Context Quintile 5 was only 82% compared to the 87% retention rate for system students in Context Quintile 1. From a different perspective, the attrition rate for STEM students in Context Quintile 5 was nearly 40% larger than the attrition rate for STEM students in Context Quintile 1 (18% versus 13%). This tells us that paying attention to both SAT scores and environmental context information can help institutions to target instructional supports to the students that need them most to ensure that all students have the opportunity to be successful in their chosen major and have additional opportunities later on for graduate school and recruitment by top employers, long-term outcomes that may in part be influenced by cumulative GPA.

Figure 26: Mean SAT Scores by STEM Students in the Bottom Third on Second-Year Cumulative GPA (within major and institution), Context Quintiles 1 (Low Challenge) and 5 (High Challenge)

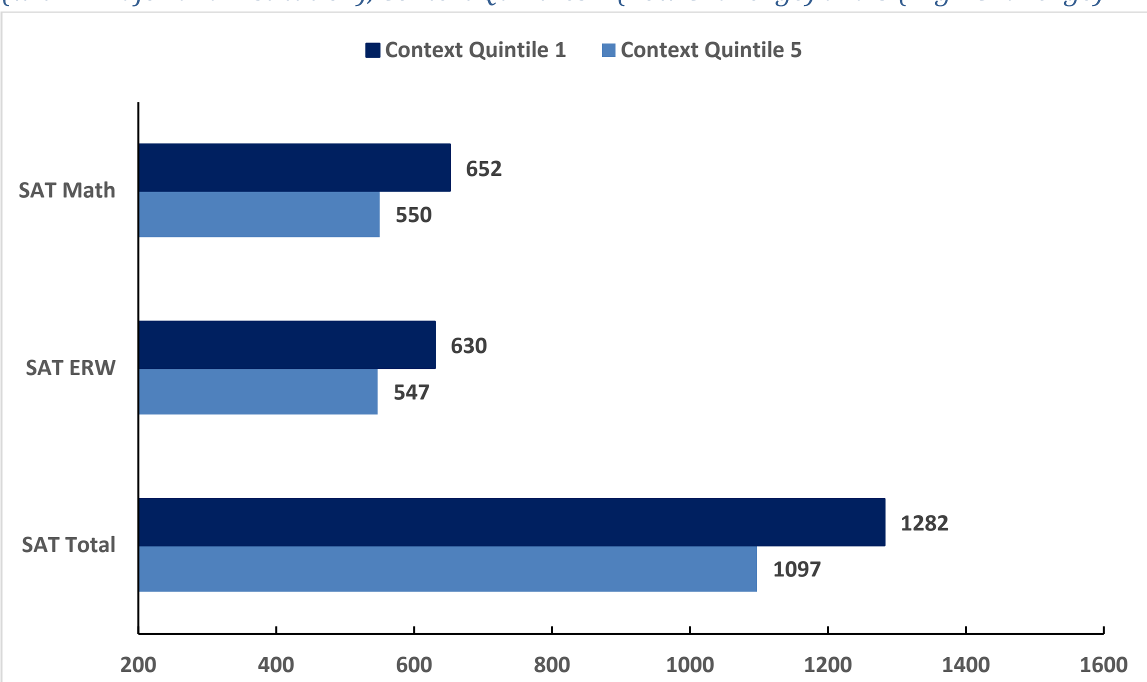
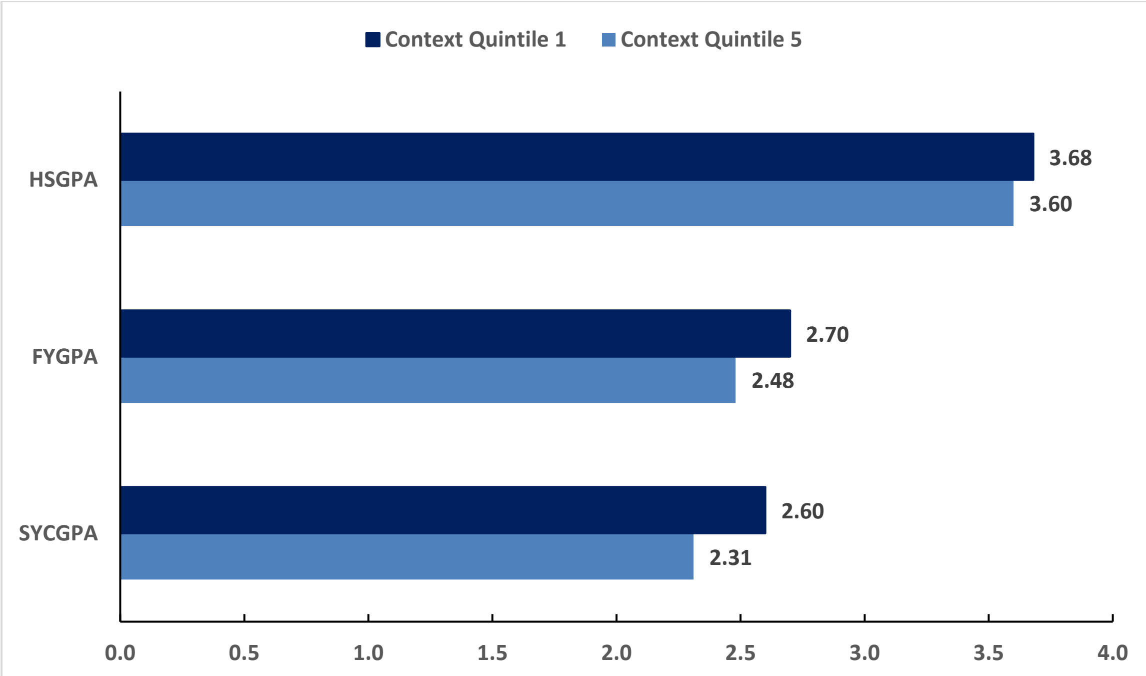


Figure 27: Mean GPAs by STEM Students in the Bottom Third on Second-Year Cumulative GPA (within major and institution), Context Quintiles 1 (Low Challenge) and 5 (High Challenge)



Discussion

This study examined how institutions can most effectively consider and use SAT scores and HSGPA to understand student performance by academic major in order to maximize successful outcomes for both the students and the institution. The study findings offer insight about differences in departmental grading practices and how those differences need to be factored into predictive models, and how the use of SAT, HSGPA, and student's environmental context information can jointly inform advising decisions as well as the implementation of targeted academic support to promote student opportunities and success in different majors.

The descriptive statistics confirm trends that have existed for decades: STEM majors tend to have higher levels of precollege academic achievement, but lower college grades compared to their non-STEM peers. These differences suggested differential grading standards across academic majors, which previous research has also found, and the logistic regression analyses indicated that students with the same SAT scores and HSGPAs had different chances of earning a SYCGPA of 3.0 or higher across the 13 academic majors included in the study.

Regardless of differences in grading standards, the correlational analyses found that the SAT was a valid predictor of SYCGPA for all 13 academic majors included in the study, and the SAT always added incremental validity beyond that of HSGPA. Moreover, the SAT was stronger than HSGPA as a predictor of SYCGPA in nearly half of the academic majors, including three of the five STEM majors. This is in contrast to overall analyses that ignore academic majors and show HSGPA to be slightly stronger than the SAT as a predictor of undergraduate GPA. However, the results of overall and academic major analyses do agree in an important way: Overall and for all 13 academic majors, the joint use of the SAT and HSGPA was always better than using the SAT or HSGPA alone to predict SYCGPA. Accurately understanding how students may be expected to perform in a major not only helps an institution to appropriately plan for departmental resources but to most effectively target academic support and additional instruction to those students most likely to benefit from it.

Another key finding from the correlational analyses was that conducting analyses at the academic major level increased the average validity of both SAT scores and HSGPA when compared to the mean validities of these predictors when institution level correlational analyses ignored students' academic majors. Each student's GPA is a unique measure, but in practice GPA is usually considered a common metric despite students taking different courses with different grading standards. A more-refined study would examine the validity of the SAT and HSGPA as predictors of individual courses within an institution, followed by weighting and aggregating the results at the institution level, and followed by weighting and aggregating results across institutions. An alternative would be to make grade adjustments based on course difficulty estimates at the institution level, calculate adjusted GPAs for each student at the institution level, calculate correlations at the institution level, and then weight, aggregate, and average the correlations across institutions. These alternative approaches are exceedingly complex, and conducting analyses at the academic major level proved sufficient to show that the predictive strength of the SAT and HSGPA are stronger than many believe.

The final set of analyses add to our knowledge of students from educationally disadvantaged environments that have declared a STEM major. Previous research found that students from educationally disadvantaged environments, even when they have the same SAT scores and HSGPAs as their peers, earn grades slightly lower than predicted using their SAT scores and HSGPAs (Westrick et al., 2020). The supplemental analyses in the current study confirmed the finding that precollege environmental challenges moderate students' academic performances in college. This added SAT information can help institutions differentiate which of their admitted students will be most likely to benefit from extra support to ensure that these students persist in their studies, graduate, pursue post-graduate opportunities in STEM (if desired), and contribute to the STEM fields in the coming decades.

Conclusion

To summarize, findings from the current study affirm the value and effectiveness of the SAT as a tool for institutions to use to inform admission, academic advising, and instructional support decisions by academic major. Results show that:

- SAT scores are strongly predictive of college performance across multiple academic majors—students with higher SAT scores are more likely to have higher grades in college.
- The SAT was stronger than HSGPA as a predictor of SYCGPA in nearly half of the academic majors.

- The joint use of the SAT and HSGPA was always better than using the SAT or HSGPA alone to predict SYCGPA.
- For students with the same HSGPA, their chances of earning a SYCGPA of 3.0 or higher varied depending on their SAT scores. This was found across all academic majors included in the study.
- Students' chances of earning a SYCGPA of 3.0 or higher varied across academic majors, suggesting that grading practices varied across academic majors.
- The SAT can be used to increase the diversity of the student body in STEM fields by helping institutions to confidently admit the students they are most interested in to shape a class in keeping with their mission and goals, while remaining fully aware of which students may benefit from additional instructional support in the major field in order to maximize their success in college and beyond.

In addition to studying these SAT and HSGPA relationships from a national perspective as part of a comprehensive SAT validity research agenda, College Board also provides a free online service for higher education institutions and systems (Admitted Class Evaluation Service, ACES) to conduct campus or system-specific validity studies (with outcomes such as FYGPA, course grades, retention, and completion) that meet their specific institutional needs and help to provide greater context and meaning for the use of College Board scores in different enrollment management processes.

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Appendix

Table A1: Descriptive Statistics by Context Quintiles

Context Quintile	Measure	*n*	*Mean*	*SD*	*Min*	*Max*
Context Quintile 1	SAT ERW	20,774	628	73	330	800
	SAT Math	20,774	633	84	200	800
	SAT Total	20,774	1261	144	550	1600
	SAT Tilt	20,774	0.06	0.61	-2.45	3.60
	HSGPA	20,774	3.73	0.42	1.33	4.33
	FYGPA	20,774	3.30	0.55	0.07	4.27
	SYCGPA	20,774	3.29	0.53	0.13	4.16
	Year 3 Retention	20,774	0.94	0.23	0.00	1.00
Context Quintile 2	SAT ERW	12,575	614	74	200	800
	SAT Math	12,575	610	84	280	800
	SAT Total	12,575	1223	145	680	1600
	SAT Tilt	12,575	-0.02	0.63	-2.38	3.07
	HSGPA	12,575	3.75	0.43	1.67	4.33
	FYGPA	12,575	3.24	0.56	0.57	4.30
	SYCGPA	12,575	3.24	0.54	0.23	4.11
	Year 3 Retention	12,575	0.93	0.25	0.00	1.00
Context Quintile 3	SAT ERW	9,811	600	76	200	800
	SAT Math	9,811	594	85	200	800
	SAT Total	9,811	1195	148	400	1590
	SAT Tilt	9,811	-0.03	0.63	-2.64	2.64
	HSGPA	9,811	3.76	0.44	1.33	4.33
	FYGPA	9,811	3.19	0.59	0.07	4.27
	SYCGPA	9,811	3.17	0.59	0.05	4.10
	Year 3 Retention	9,811	0.91	0.28	0.00	1.00
Context Quintile 4	SAT ERW	6,826	582	79	310	800
	SAT Math	6,826	572	85	210	800
	SAT Total	6,826	1154	151	580	1590
	SAT Tilt	6,826	-0.06	0.64	-3.10	2.90
	HSGPA	6,826	3.72	0.47	1.67	4.33
	FYGPA	6,826	3.10	0.62	0.13	4.30
	SYCGPA	6,826	3.08	0.62	0.13	4.14
	Year 3 Retention	6,826	0.90	0.30	0.00	1.00
Context Quintile 5	SAT ERW	4,938	539	78	280	790
	SAT Math	4,938	529	81	250	800
	SAT Total	4,938	1068	146	560	1570
	SAT Tilt	4,938	-0.03	0.63	-2.35	2.81
	HSGPA	4,938	3.61	0.50	1.33	4.33
	FYGPA	4,938	2.95	0.64	0.19	4.08
	SYCGPA	4,938	2.92	0.65	0.19	4.00
	Year 3 Retention	4,938	0.87	0.33	0.00	1.00

Note: *n*=number of students; *SD*=standard deviation; ERW=Evidence-based Reading and Writing; HSGPA=high school grade point average; FYGPA=first-year grade point average; SYCGPA=second-year cumulative grade point average.

Table A2: Raw Correlations of Predictors with Second-Year Cumulative GPA by Academic Majors

Academic Major or Grouping	*k*	*n*	ERW	Math	SAT	HSGPA	SAT+HSGPA	IV
Biological and biomedical sciences	60	8,034	.36	.39	.44	.36	.52	.16
Business, management, marketing, and related support services	58	10,064	.30	.30	.35	.37	.47	.10
Communication, journalism, and related programs	37	2,201	.34	.29	.39	.43	.54	.11
Computer and information sciences and support services	34	2,403	.27	.31	.35	.35	.47	.12
Education	39	2,307	.32	.28	.37	.38	.49	.11
Engineering	33	7,422	.29	.38	.40	.32	.48	.16
English language and literature/letters	26	802	.33	.31	.42	.38	.54	.16
Health professions and related programs	49	6,267	.33	.33	.38	.38	.49	.11
Liberal arts and sciences, general studies, and humanities	37	5,189	.26	.21	.29	.38	.44	.06
Mathematics and statistics	20	761	.32	.27	.40	.40	.52	.12
Physical sciences	34	1,518	.37	.38	.44	.37	.54	.17
Psychology	50	3,299	.33	.33	.40	.33	.48	.15
Social sciences	53	4,657	.37	.28	.39	.33	.48	.15
Weighted Average across 5 STEM Majors	60	20,138	.32	.37	.41	.35	.50	.15
Weighted Average across 8 Non-STEM Majors	72	34,786	.32	.29	.36	.37	.48	.11
Weighted Average across 13 Majors	73	54,924	.32	.32	.38	.36	.49	.13
Overall (ignoring students' academic majors)	73	54,924	.31	.29	.34	.36	.44	.08

Note: *k*=number of institutional studies; *n*=number of students; ERW=Evidence-based Reading and Writing; HSGPA=high school grade point average; IV=incremental validity.

Table A3: Descriptive Statistics for Students Categorized as STEM or Non-STEM, Overall and by Context Quintiles

Group	Context Quintile		SAT ERW		SAT Math		SAT Total		SAT Tilt		HSGPA		FYGPA		SYCGPA		Ret. 3
		n	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*	*Mean*
STEM	CQ1	4,636	653	62	675	70	1328	118	-0.21	0.59	3.85	0.36	3.31	0.55	3.28	0.54	94%
	CQ2	3,303	638	66	653	76	1291	128	-0.14	0.61	3.87	0.37	3.23	0.56	3.20	0.55	94%
	CQ3	2,788	626	70	639	78	1264	133	-0.13	0.62	3.86	0.37	3.18	0.58	3.14	0.58	92%
	CQ4	1,905	608	75	614	83	1221	144	-0.08	0.63	3.84	0.41	3.07	0.62	3.04	0.62	91%
	CQ5	1,251	559	78	564	81	1123	146	-0.10	0.63	3.71	0.46	2.88	0.62	2.84	0.65	89%
	Overall	13,883	629	73	644	83	1273	143	-0.15	0.61	3.84	0.38	3.19	0.59	3.16	0.59	93%
Non-STEM	CQ1	7,197	617	67	614	76	1232	128	0.01	0.63	3.67	0.42	3.31	0.54	3.3	0.52	94%
	CQ2	5,158	610	68	596	75	1207	127	0.11	0.63	3.72	0.41	3.26	0.56	3.26	0.53	94%
	CQ3	4,313	596	71	580	74	1176	129	0.12	0.63	3.72	0.43	3.21	0.58	3.19	0.57	93%
	CQ4	3,086	578	75	559	77	1137	138	0.14	0.63	3.71	0.46	3.14	0.59	3.11	0.59	91%
	CQ5	2,209	534	77	517	74	1052	138	0.09	0.62	3.59	0.49	2.98	0.62	2.93	0.63	89%
	Overall	21,963	598	75	586	81	1183	142	0.08	0.63	3.69	0.43	3.22	0.57	3.21	0.57	93%

Note: *n*=number of students; *SD*=standard deviation; SYCGPA=second-year cumulative grade point average; ERW=Evidence-based Reading and Writing; HSGPA=high school grade point average; Ret.3=third-year retention rate.

Table A4: Descriptive Statistics for Students Disaggregated by Second-Year Cumulative GPA Thirds within Academic Majors

			SYCGPA		ERW		Math		Total Score		SAT Tilt		HSGPA		Ret. 3
STEM Major	**Third**	***n***	***mean***	***SD***	***mean***	***SD***	***mean***	***SD***	***mean***	***SD***	***mean***	***SD***	***mean***	***SD***	***mean***
Biological and biomedical sciences	Top	1,723	3.73	0.21	646	68	651	75	1298	130	0.05	0.57	3.97	0.32	97%
	Middle	1,738	3.26	0.26	614	69	607	76	1221	131	-0.04	0.62	3.83	0.36	97%
	Bottom	1,724	2.55	0.50	591	71	585	80	1176	139	-0.03	0.60	3.67	0.42	86%
Computer and information sciences and support services	Top	604	3.71	0.19	643	71	667	82	1310	139	0.23	0.63	3.89	0.33	97%
	Middle	618	3.23	0.23	621	73	634	82	1255	140	0.14	0.64	3.72	0.42	97%
	Bottom	607	2.49	0.47	601	74	615	80	1216	141	0.16	0.62	3.57	0.45	84%
Engineering	Top	1,740	3.73	0.19	667	66	701	66	1368	119	0.31	0.55	4.01	0.29	95%
	Middle	1,748	3.20	0.21	640	64	669	67	1308	118	0.27	0.57	3.90	0.34	95%
	Bottom	1,743	2.52	0.42	625	70	648	72	1273	129	0.23	0.58	3.79	0.38	87%
Mathematics and statistics	Top	187	3.72	0.19	659	73	701	77	1360	133	0.39	0.66	4.01	0.30	95%
	Middle	193	3.26	0.24	624	75	670	67	1293	126	0.45	0.64	3.87	0.36	96%
	Bottom	192	2.65	0.44	608	70	656	79	1264	135	0.47	0.64	3.69	0.44	89%
Physical sciences	Top	352	3.71	0.22	661	73	679	77	1340	134	0.16	0.64	3.94	0.34	97%
	Middle	359	3.16	0.23	619	73	629	80	1248	139	0.11	0.62	3.85	0.35	96%
	Bottom	355	2.45	0.45	603	72	613	76	1216	134	0.12	0.64	3.67	0.41	83%

Note: *n*=number of students; *SD*=standard deviation; SYCGPA=second-year cumulative grade point average; ERW=Evidence-based Reading and Writing; HSGPA=high school grade point average; Ret.3=third-year retention rate.

Table A5: Means (SDs) for Measures for STEM Students in the Bottom Third of SYCGPA within Academic Majors, by Context Quintiles

STEM Major	Context Quintile	*n*	SYCGPA *Mean*	SYCGPA *SD*	SAT ERW *Mean*	SAT ERW *SD*	SAT Math *Mean*	SAT Math *SD*	SAT Total *Mean*	SAT Total *SD*	SAT Tilt *Mean*	SAT Tilt *SD*	HSGPA *Mean*	HSGPA *SD*	FYGPA *Mean*	FYGPA *SD*	Ret 3 *Mean*
Biological and biomedical sciences	1	398	2.65	0.46	617	62	617	74	1234	123	0.01	0.59	3.64	0.42	2.72	0.48	86%
	2	378	2.61	0.46	604	67	598	76	1202	129	-0.03	0.60	3.70	0.43	2.71	0.51	88%
	3	362	2.59	0.50	596	65	591	69	1187	120	-0.02	0.60	3.72	0.38	2.67	0.54	85%
	4	337	2.47	0.53	581	69	567	78	1148	133	-0.10	0.60	3.69	0.43	2.58	0.52	85%
	5	249	2.34	0.51	538	72	528	80	1066	139	-0.02	0.60	3.59	0.45	2.49	0.50	87%
Computer and information sciences and support services	1	183	2.53	0.46	623	69	647	67	1270	123	0.25	0.56	3.55	0.40	2.62	0.55	83%
	2	124	2.59	0.46	606	64	610	74	1216	124	0.07	0.58	3.60	0.47	2.64	0.49	87%
	3	144	2.44	0.47	605	70	618	85	1223	139	0.15	0.68	3.58	0.46	2.59	0.49	86%
	4	93	2.39	0.51	586	75	590	76	1176	135	0.07	0.67	3.54	0.48	2.49	0.53	76%
	5	63	2.46	0.41	541	81	563	83	1104	152	0.27	0.62	3.60	0.53	2.62	0.52	86%
Engineering	1	537	2.59	0.38	644	57	675	57	1319	98	0.30	0.56	3.77	0.34	2.72	0.45	88%
	2	407	2.57	0.39	639	61	662	61	1301	106	0.22	0.59	3.83	0.37	2.67	0.44	90%
	3	354	2.54	0.38	627	68	648	64	1275	118	0.20	0.58	3.85	0.35	2.64	0.41	87%
	4	260	2.51	0.46	610	74	622	78	1232	140	0.13	0.58	3.80	0.41	2.62	0.50	87%
	5	185	2.23	0.48	558	78	573	77	1132	142	0.19	0.60	3.65	0.46	2.42	0.49	76%
Mathematics and statistics	1	54	2.79	0.35	626	60	699	54	1325	93	0.70	0.64	3.73	0.31	2.79	0.40	96%
	2	37	2.67	0.48	636	58	666	74	1302	120	0.29	0.55	3.68	0.38	2.76	0.57	89%
	3	46	2.71	0.37	612	61	658	65	1270	103	0.46	0.71	3.83	0.34	2.83	0.48	85%
	4	28	2.63	0.43	605	70	647	74	1252	134	0.42	0.52	3.71	0.63	2.69	0.58	96%
	5	27	2.29	0.47	531	70	563	81	1094	135	0.37	0.67	3.36	0.51	2.48	0.37	74%
Physical sciences	1	101	2.49	0.42	624	69	649	72	1273	129	0.26	0.55	3.57	0.43	2.58	0.52	89%
	2	75	2.51	0.41	619	74	631	67	1250	122	0.13	0.70	3.72	0.37	2.62	0.49	85%
	3	70	2.45	0.49	598	63	609	60	1207	107	0.13	0.60	3.74	0.39	2.60	0.46	80%
	4	59	2.42	0.45	584	66	585	73	1169	119	0.06	0.71	3.73	0.38	2.55	0.54	78%
	5	50	2.29	0.46	568	78	550	72	1119	137	-0.12	0.61	3.64	0.47	2.47	0.44	80%
STEM Overall	1	1,273	2.60	0.42	630	62	652	70	1282	118	0.22	0.60	3.68	0.39	2.70	0.48	87%
	2	1,021	2.59	0.43	620	66	630	76	1250	127	0.11	0.61	3.74	0.41	2.68	0.48	89%
	3	976	2.54	0.45	610	68	620	74	1230	127	0.12	0.62	3.76	0.39	2.65	0.48	85%
	4	777	2.48	0.50	593	72	592	82	1185	140	0.03	0.62	3.71	0.44	2.58	0.52	85%
	5	574	2.31	0.49	547	76	550	81	1097	144	0.09	0.62	3.60	0.47	2.48	0.49	82%

Note: SYCGPA=second-year cumulative grade point average; ERW=Evidence-based Reading and Writing; HSGPA=high school grade point average; FYGPA=first-year grade point average; n=number of students; SD=standard deviation; Ret.3=third-year retention rate.