Multilevel analysis of student pathways to college

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Abstract

This study examined the relationship between academic preparation and postsecondary educational outcomes. To uncover the factors that influence high school course-taking patterns and outcomes, multilevel modeling was conducted using data from a nationally representative sample of high school students from the Education Longitudinal Study of 2002. Results indicated (1) significant effects from student, family, and school predictors on course-taking patterns with one of the strongest predictors being students' previous math achievement, and (2) significant effects from course-taking patterns on enrollment in postsecondary institution types with math course-taking pattern having the largest impact. Policy implications for educators and administrators are discussed.

Keyword: curriculum, academic achievement, school environment, high school students, academic specialization

Multilevel Analysis of Student Pathways to College

The importance of academic preparation in high school has been a topic of interest in education research because of its connection to students' various future outcomes. Research has indicated that there is a link between academic preparedness and success in post-secondary education outcomes (ACT, 2008; Adelman, 1999; 2006; U.S. Department of Education, 2001). These educational outcomes, in turn, affect the ability of students to become self-reliant, self-sufficient and successfully manage their lives in an increasingly complex world (Kuh, Kinzie, Buckley, Bridges, Hayek, 2006). As globalization becomes more expansive, there is an increase in the need for more specialized education and training. Students who are academically prepared with adequate knowledge, skills, and training may have far more future opportunities in their academic and/or employment choices than those with less education and training. Student experiences, that is, their prior and current histories, backgrounds, education, training, and individual characteristics all can influence their future outcomes. Therefore, one of the central questions in determining best policies and effective educational practices is: What are the factors that facilitate students' pathways to college?

The trend in college enrollments indicates that there is a substantial increase in the number of students who are going to college. According to the U.S. Department of Education (2008), there was a sixteen percent increase in enrollment in degree-granting institutions between 1985 and 1995. The rate of increase between 1995 and 2005 was even greater at twenty-three percent. It is estimated that most jobs in the twenty-first century will require post-secondary education training, that is, more than two-thirds of positions require students to have some level of knowledge and skills beyond the high school level (Carnevale & Desrochers, 2003).

Degree obtainment often translates into differences in future resources and levels of income (Carnevale & Rose, 1998). For example, Carnevale and Desrochers (2001) indicate that even if a student has just one year of post-secondary education that can mean the difference of a 15 percent increase in earnings throughout the student's lifetime. The U.S. Bureau of Labor Statistics indicate that those who earn a bachelor's degree and above substantially increase their earning capacity compared to those who have less than a bachelor's degree education (Dohm & Wyatt, 2002). This has important implications for students' life chances and opportunities for success. Therefore, it is crucial for students to be well-prepared to enter into higher education institutions and to persist once enrolled. Of particular concern in the pathways to college is the issue of access and opportunities to participate in the types of courses that will adequately prepare students for post-secondary education.

Past research has found that students who were college graduates were likely to have taken rigorous courses while in high school (Adelman, 1999; 2006; U.S. Department of Education, 2001). In particular, Adelman's (1999; 2006) national studies on academic pathways from high school to college examined factors that positively contributed to academic performance and college degree completion. Consistent across both studies was the significance of a rigorous, challenging, and intense curriculum on students' post-secondary academic success. Studies have also suggested that course-taking patterns has effects on students' choice of academic majors or careers (Trusty, 2002; Tyson, Lee, Borman, & Hanson, 2007). The implications of these choices may be significant in determining students' life chances. Therefore, the patterns of course-work, especially during high school are a crucial component of academic preparation. For example, examinations of course-taking trends for high school students reveal several patterns in mathematics and science (Dalton, Ingels, Downing, Bozick, 2007). According to National Center for Educational Statistics data, between 1982 and 2004, mathematics course-taking increased overall with students earning more math credits and taking more advanced level courses. The trends for science are similar to mathematics during the same time-period; there was an increase in the number of course-taking in science subjects and students were more likely to have completed some advanced course-work by the time they graduated from high school. For both subjects, the increase in number of credits is equivalent to the addition of one full academic year that students completed. Similar trends were also found for student completion of English and foreign language coursework. The percentage of students who completed some level of honors English rose from 13 percent in 1982 to 33 percent in 2004; for foreign language the rate was 15 percent in 1982 and increased to 35 percent in 2004 (Planty, Provasnik, & Daniel, 2007). Based on the significance of patterns of coursework and the focus on the advancement of academic preparation through improving high school curriculum, it is worthwhile to examine the factors that influence course-taking patterns and the impact of students' high school course-taking as it relates to future outcomes.

Over the past several decades, there has been an increase in the number of states that have adopted state level high school graduation requirements (Planty, Provasnik, & Daniel, 2007). Thus, many U.S. schools are attempting to improve curriculum in order to better prepare students for post-secondary education experiences. Schools are working towards creating and fostering college-going environments in addition to ensuring that students meet high school graduation requirements. Trends in course-taking and academic major choices suggest increases in advanced course-taking in core subjects, and in particular, mathematics and science (Dalton, Ingels, Downing, & Bozick, 2007). The emphasis that schools place on adequately preparing their students for future opportunities is evident in the fact that over the last decade, students are enrolling in and completing more academic courses (Legum, Caldwell, Davis, Haynes, Hill, Litavecz, Rizzo, Rust, Vo, & Gorman, 1998; Perkins, Kleiner, Roey, Brown, 2004; U.S. Department of Education, 2000).

Past research has indicated the importance of high-level curriculum in the academic preparation of high school students. Students who enroll in rigorous and challenging course-work are more likely to have high academic performance, attend college and earn degrees (U.S. Department of Education, 2001; Tyson, Lee, Borman, & Hanson, 2007). Researchers have also suggested that the level of rigor in high school course-work is linked to students' high college aspirations, expectations, and perseverance (Burkam & Lee, 2003; Horn & Kojaku, 2001; Trusty, 2002; Trusty & Niles, 2003). For example, the likelihood of students who took advanced math courses in high school more than doubled their rate of bachelor's degree completion (Trusty & Niles, 2003). A national study by the U.S. Department of Education indicated that students who took algebra or foreign language courses were likely to pursue degrees in four-year institutions (NCES, 1999). This suggests a relationship between the types of coursework taken in high school and the type of post-secondary institutions that students enroll. Essentially, adequate academic preparation in the form of intensive course-work and programs in high school increases the likelihood of success in higher education, which influences career opportunities and earning capacity. Consistent across studies of academic success trajectories is the recommendation that schools provide students with college readiness skills and strengthen programs that meet standards for post-secondary education. In doing so, schools and educators are accounting for the educational pathways that affect students' life chances and the ability to improve their overall quality of life.

However, not all students experience the types of courses that adequately prepare them for life after high school. The availability of courses and the level of rigor vary across schools (Planty, Provasnik, & Daniel, 2007). Furthermore, high school course-taking patterns also vary according to student backgrounds. Ethnic minorities, students from less affluent backgrounds, and public school students tend to take less rigorous courses while in high school than do their peers (Alexander & Cook, 1982; Finn, Gerber, & Wang, 2002; Hoffer, Greeley & Coleman, 1985). Students who take less rigorous courses are less likely to attain a college degree and do not do as well in the workforce as students who take more rigorous courses (Adelman 1999; Altonji, 1995; Hotchkiss, & Dorsten; 1987). Research has also indicated that nationally, high schools are not consistent in offering high-level coursework (Adelman, 2006). Availability of advanced-level courses varies across schools for numerous reasons. Ethnic minority status and low socio-economic status are some of the factors that were related to limited access to advanced-level curriculum. For example, compared to 59% of White students, only 45% of Latino students were enrolled in a high school that had calculus as a course option (Adelman, 2006). Furthermore, researchers have suggested that access to higher education for underrepresented groups involves a multitude of factors that include eligibility standards, quality teaching and learning experiences, ability to successfully navigate the school systems, availability of resources and aid, and academic and personal support networks (Kuh et al., 2006; Jones, Yonezawa, Ballesteros, & Mehan, 2002). It is within these parameters, among others, that student educational opportunities and success are shaped.

The diversity of student experiences factors into their academic pathways and outcomes. Studies that have examined individual student characteristics as it relates to course-taking patterns or college enrollment have noted that student backgrounds have significant influences on academic perceptions, choices, and performance. For example, studies have suggested that parental background including education level influences students' experiences and choices in high school and college (U.S. Department of Education, 2001). Student course-taking and college enrollment has also been found to be related to characteristics such as parent education and student generational status (U.S. Department of Education, 2001). In Stewart's (2008) study, individual level characteristics such as family socio-economic status (SES) and family structure were found to be significant factors in student academic achievement. That is, compared to students with lower SES and from single-parent families, students who had higher SES and had two-parent families showed higher academic achievement.

Research has also suggested that students' previous achievement is a significant predictor of college success. Researchers have found evidence that support the use of high school grade point average as one of the best predictors of college success (Kobrin, Patterson, Shaw, Mattern, Barbuti, 2008). A study by Geiser and Santelices (2007) found that high school grade point average was the strongest predictor of academic performance across the four years of college for students enrolled in universities in California. Another study on the predictors of college success also found students' high school ability and academic performance were able to predict both short- and long-term successful academic achievement in college (Harackiewicz, Barron, Tauer, Elliott, 2002). In addition, a more recent national study (Adelman, 2006) also found that high school performance in the form of grades was predictive of bachelor's degree completion.

Because students are nested in schools, specific characteristics of schools also play a role in students' educational pathways. School characteristics such as organization, resources, climate, and teachers help shape the educational experiences of students. Researchers have indicated the connection between school characteristics and academic outcomes (Carbonaro, 2005; Rumberger & Palardy, 2005). The climate of schools, for example, may be a significant factor in student academic achievement. In a study by Benner, Graham, and Mistry (2008), results indicated a relationship between school climate and student achievement. They found that students in higher performing schools had positive perceptions about their sense of belonging and the school climate in general. Organization structure such as school size is also another factor that impacts student academic experience. For example, Lee and Burkham (2003) found that larger schools tend to have lower test scores than smaller schools.

The challenge for educators is to better understand the influence of high school course-taking on post-secondary education outcomes. Given the diversity of the context of education, it is important to also consider the student and school characteristics that affect academic choices and decisions. For some students, the context of their academic and personal environments influences the educational choices and decisions that impact future success (Ma & Willms, 1999; Trusty & Niles, 2003; Wang & Goldschmidt, 2003). In order to create effective programs that will better prepare students to participate and contribute to their community on a social and economic scale, educators and researchers need to examine the educational pathways that influence student experiences. The complexity that exists within the relationship between academic preparation and student future outcomes is difficult to uncover and few studies have examined this relationship from a multi-level approach on nationally representative samples. The process by which course-taking affects post-secondary educational outcomes and the factors that contribute to a positive relationship is still unclear and needs to be fully explored. By examining students' academic preparation, in particular, course-taking pattern as nested within other systems of factors that could possibly influence educational pathways to college, this study considers the many layers of student and school characteristics. Student academic preparation is necessary for building and enhancing academic and occupational skills. In order to create or implement best practices for ensuring positive pathways to college, the underlying individual or academic factors must be understood.

Few studies have explored the student and school factors related to advanced course-taking patterns in core subjects using nationally representative samples (Downer-Assaf, 1995; Ma, 2000). Therefore, using the longitudinal data from a nationally representative sample, this study intends to advance the research on college preparation by identifying various factors related to students' advanced coursework of high school students in the United States. Also, it is important to consider the issue of academic preparation in high school from a K-16 perspective because the outcomes have practical implications for high school educators, parents and policymakers. Thus, this study investigated the link between college preparation in high school and higher education. Specifically, we comprehensively explored the relationship between high school students' course-taking patterns in core subjects and their access to and choice of postsecondary institutions.

This study seeks to contribute to a better understanding of the pathways to college. Given the differences in course-taking patterns, differences in postsecondary educational outcomes are not surprising. Therefore, this study investigated how high school students' course-taking patterns in mathematics, science, foreign language, and English influence students' postsecondary education experience. Additionally, this study intended to understand the sources of academic preparation by identifying the factors that make a difference in students' course-taking patterns in mathematics, science, foreign language, and English. Taking a holistic approach to students' pathways to college will help educators, policymakers, and parents to narrow the achievement gap among students. This study addresses the following questions:

1. What student and school characteristics influence high school students' course-taking pattern in mathematics, science, foreign language and English?
2. Among students who graduated and enrolled in college, how do their high school course-taking pattern in mathematics, science, foreign language and English affect their college enrollment (4yr –highly selective, moderately selective, 4yr-inclusive, 2yr or less)?

Method

Data and Samples

This study utilized four major components of the Education Longitudinal Study (ELS): the base-year interview, the first follow-up interview, the high school transcript data, and the second follow-up interview. ELS is the most recent secondary school longitudinal survey conducted by the National Center for Educational Statistics (NCES) and tracks the educational and developmental experiences of a nationally representative sample of students in public and private high schools in the United States. Since the base-year interview in 2002, the first follow-up interview took place in spring of 2004, when most sample members were seniors in high school. The high school transcript data were collected starting in the winter of 2004-05, almost 1 year after most sample members had graduated from high school. Second follow-up took place in 2006 when most were 2 years out of high school. Second follow-up data include information related to post-secondary education. Using these four components of the ELS data, the current study focuses specifically on the transition to higher education for the high school sophomore class of 2002.

The first analysis, to examine predictors of course-taking patterns in core subjects, was based on the data from approximately 14,713 students attending 751 schools. This is a longitudinal sample of students who completed the survey at the base year and first follow-up and have high school transcript data. The second analysis, to examine predictors of college enrollment, was based on 10,599 students who graduated and enrolled in postsecondary institution in 2006. By 2006, approximately two years after their expected high school graduation date, 88 percent of spring 2002 sophomores had graduated with a diploma, and 4 percent had earned a GED or other equivalency by that point. Seventy percent of spring 2002 sophomores had enrolled in a post-secondary institution by 2006. The approximate sample weight was applied so that the results generalize to 2002 sophomore sample.

Variables and Measures

Independent variable. At the student level, four types of variables were constructed. The first type represents demographic characteristics of students (e.g., gender and ethnicity). The second type represents a family background variable: socioeconomic status, which is a composite measure developed by NCES based on father's education level, mother's education level, father's occupation, mother's occupation, and family income. The third type of variables represents students' academic background variables. Prior achievement was measured by standardized test score in 10^{th} grade math and reading. Student test scores on the 10^{th} grade test in math and reading are included as a covariate because students' decisions to enroll in future courses are influenced by their perceived ability to do work that is more advanced.

At the school level, four types of school characteristics were constructed based on prior school effectiveness research. To control for socioeconomic composition, the mean SES of students in the school was included. As a structural characteristic of school, type of school (public vs. others) was included. The third set of variables measured school resources: a ratio of student/fulltime teachers in mathematics, science, foreign language, English and guidance counselors. The last set of variables measured school process: the percent of students in college preparatory program, the percent of former graduates who went to 4-year colleges, and the proportion of student who received college entrance information from counselors, teachers, and parents.

Dependent variable. The dependent variables in this study were students' course-taking pattern in core subjects (i.e., mathematics, science, foreign language and English) and the selectivity of post-secondary institutions in which they enrolled.

Measuring High School Course-taking

There are various ways to measure the academic course-work that students complete. For example, one can measure the number of courses a student has completed in different subjects (e.g., whether a student completed two, three, or four courses in mathematics). Another method is to use the academic pipeline, developed by Burkam and Lee (2003), which measures the highest level of coursework completed in different subjects. In this study, we utilized the academic pipeline measure since it permits comparisons of graduates who completed courses at each level in a given year who reach each of the levels, as well as comparisons among different graduating classes.

Academic pipelines organize transcript data in different subjects into levels based on the normal progression and difficulty of courses within these subject areas. Each level includes courses either of similar academic challenges and difficulty or at the same stage in the progression of learning in that subject area. In the mathematics pipeline, algebra I is placed at a level lower in the pipeline continuum than algebra II because algebra I is traditionally completed before algebra II and is generally less academically difficult or complex. In this study, we utilized academic pipelines to measure high school students' course-taking pattern. Academic pipeline measures allow one to infer that high school graduates who have completed courses at the higher levels of a pipeline have completed more advanced coursework than graduates whose courses fall at the lower levels of the pipeline.

Mathematics pipeline. Burkam and Lee (2003) developed mathematics and science pipeline measures as described below. Mathematics coursework pipeline is created based on the natural sequence of mathematics courses. The mathematics pipeline measures progression from no mathematics or non-academic courses to low, middle, and advanced coursework. Each level in the pipeline represents the highest level of mathematics coursework that a graduate completed in high school. The original measure has eight levels as follows.

1. No mathematics: students who completed either no coursework in mathematics or only basic or remedial-level mathematics.
2. Non-academic: nonacademic courses (general, basic skills, consumer mathematics)
3. Low academic: Highest completed course is pre-algebra; algebra I (part I), or algebra I (part II)
4. Middle academic I (Algebra I/ Geometry level)
5. Middle academic II (Algebra II level)
6. Advanced mathematics I (Trigonometry/Algebra III level)
7. Advanced mathematics II (Pre-calculus level)
8. Advanced mathematics III (Calculus level): Highest completed course is Advanced Placement (AP) calculus; calculus; or calculus/analytical geometry.

Science pipeline. Science pipeline measures are more difficult to develop because there is no common or easily defined set of sequence for science courses. Schools differ in curricula and prerequisites. Depending on a school's curriculum, students can choose a wide variety of courses. Therefore, the method used to create the science pipeline differs from that used to create the mathematics pipeline. Burkam and Lee (2003) developed four groups using the average grade at which each science course was taken and sequences within each category; (1) life science pipeline (e.g., biology, ecology, zoology); (2) chemistry pipeline; (3) physics pipeline; and (4) a pipeline that included all other physical science (e.g., geology, earth science, physical science). Then, these four pipelines were combined into a single pipeline as follows.

1. No science: students who completed either no coursework in science or only basic or remedial-level science.
2. Low academic level I: Primary physical science (physical science , earth science or unified science).
3. Low academic level II: Secondary physical science and basic biology (astronomy, geology, environmental science, oceanography, general physics, basic biology I, consumer or introductory chemistry).
4. Middle academic level: General biology: Highest completed course is general biology I; secondary life science (including ecology, zoology, marine biology, and human physiology); or general or honors biology II.
5. Advanced academic level I: Chemistry I or Physics I: Highest completed course is introductory chemistry, chemistry I, organic chemistry, physical chemistry, consumer chemistry, general physics, or physics I.
6. Advanced academic level II: Chemistry I and Physics I
7. Advanced academic level III: Chemistry II or Physics II or Advanced Biology: Highest completed course is advanced biology, International Baccalaureate (IB) biology II, IB biology III, AP biology, field biology, genetics, biopsychology, biochemistry and biophysics, botany, cell and molecular biology, microbiology,

anatomy, and miscellaneous specialized areas of life sciences, chemistry II, IB chemistry II, IB chemistry III, AP chemistry, physics II, IB physics, AP physics B/C.

8. Advanced academic level IV: Chemistry and physics and level 7.

Foreign language pipeline. Coursework in a foreign language follows a sequential path. Most high school students who study a foreign language typically follow a four-year long courses program in a particular language. However, not all students follow this pattern. Some students begin their studies in the middle of a sequence because they have prior knowledge of the language. Thus the highest level of completed coursework in the foreign language pipeline indicates the level of the most academically advanced course those students completed.

The foreign language pipeline included foreign language course-taking in Amharic, Arabic, Chinese, Czech, Dutch, Finnish, French, German, Greek, Hawaiian, Hebrew, Italian, Japanese, Korean, Latin, Norwegian, Polish, Portuguese, Russian, Spanish, Swahili, Swedish, Turkish, Ukrainian, or Yiddish. The foreign language pipeline has six categories as follows.

1. None: students who completed no coursework in foreign language.
2. Year 1 (1 year of 9^{th}-grade instruction) or less: Graduate completed no more than either a full Carnegie unit (1 academic year of coursework) of 9^{th} grade (year 1) foreign language instruction or half a Carnegie unit of 10^{th} grade (year 2) foreign language instruction.
3. Year 2 (1 year of 10^{th}-grade instruction) or less
4. Advanced level I: Year 3 (1 year of 11^{th}-grade instruction) or less
5. Advanced level II: Year 4 (1 year of 12^{th}-grade instruction) or less
6. Advanced level III: AP Instruction

English pipeline. English pipeline measures are more difficult to develop because there is no common or easily defined set of sequence for English language and literature courses. Therefore, we operationalized the definition of English advanced course taken using Advanced Placement/International Baccalaureate (AP/IB) courses taken. For example, if a student earned more than 1 unit of total Carnegie units in AP/IB English courses, we coded that as advanced English courses taken.

Selectivity of first attended postsecondary institution. This variable indicates the selectivity of the respondent's first-attended post-secondary institution, based on IPEDS institutional level and Carnegie institutional selectivity measure. The six categories are as follows: (1) Highly selective 4-year institution (corresponds to 25^{th} percentile ACT-equivalent scores of greater than 21); (2) Moderately selective 4-year institution (corresponds to 25^{th} percentile ACT-equivalent scores of 18 to 21); (3) Inclusive, 4-year institution (corresponds to 25^{th} percentile ACT-equivalent scores of less than 18); (4) Other 4-year institution; (5) Two-year institution; and (6)Less-than 2-year institution. Institutions identified as 4-year schools via IPEDS data with unknown Carnegie selectivity are classified as "other 4-year institution."

Statistical Analysis

This study was carried out in two stages. In the first part of the study, multi-level analysis was conducted on a sample of 14,713 students. Since students in the ELS: 2000 data are nested within schools, multi-level modeling is especially useful for handling nested data. This method allows researchers to partition the total variance in student-level outcomes into within-school and between-school variance and then to estimate the effects of both student-level and school-level factors on outcomes (Raudenbush & Bryk, 2002). Using Mplus 5, a series of two-level multinomial logistic models were tested to examine the association between course-taking patterns in mathematics, science, foreign language and English and two levels of explanatory variables (students and school level).

Specifically, at the student level, the outcome variables were modeled respectively based on student-level characteristics such as gender, ethnicity, SES, and previous academic achievement in Math and reading. The primary purpose of this model is to control for the family background and educational background of students in an effort to equalize student inputs across schools. At the school level, a series of school-level variables on between-school variations in the outcome variable were examined. School-level variables consist of two classes: background characteristics (i.e., student composition, school structure, and school resources) and school process (i.e., school practices and school climate), as described in the conceptual framework. Two multi-level models were tested. The first one was a full model which included all school-level variables. The second model was a simplified full model in which only significant variables from the proceeding step was retained in the subsequent model.

In the second stage of the study, the outcome variable (selectivity of post-secondary institution) is nominal, representing several independent categorical outcome, the models were estimated with multinomial logistic regression for the sample of 10,599 students who graduated and enrolled in postsecondary institution. The estimated coefficients from all models from the first and second parts of the study are more easily interpreted if they are transformed into odds ratio, which then represent the ratio of the predicted odds of being in that category rather than the modal category due to a one-unit increase. Thus a value of one signifies no change in the odds associated with any particular dependent variable; a value greater than one indicates that the odds of being in that category increase due to a one-unit increase in the independent variable; and a value less than one indicates that the odds of being in that category decrease due to a one-unit increase in the independent variable. The estimated effects for continuous variables (e.g., SES) were first multiplied by their standard deviation before converting to odds ratios so that the values in the tables represents the estimated effects of one standard deviation change in the predictor variable on the odds of graduating from high school.

Results

Descriptive Characteristics of Course-taking Patterns

The percentage distribution of students in each mathematics, science, and foreign language category group showed a somewhat normal distribution. Students are primarily concentrated in the middle categories. Among the high school senior class of 2004, the most frequently occurring mathematics category in eight levels is middle academic I (Algebra I) at 22.0 %, followed by middle academic II (Algebra II) at 21.5%. Almost 44% of students fall into the middle academic level of mathematics. Approximately 22% stopped at the highest mathematics course as Algebra I and nearly one fifth (21.5%) of students stopped at Algebra II. Nearly half of the graduates (40%) took beyond Algebra II at the advanced academic level including 14.4% took Trigonometry/Algebra III at advanced level I. An additional 14.5% took Pre-calculus but did not complete a calculus course. 10.7% took calculus or higher level mathematics courses (i.e., AP calculus, calculus/analytical geometry) in the advanced III level.

Among the high school senior class of 2004, approximately 28% completed Chemistry I or Physics I level followed by general biology (26.2%). Approximately 55% took advanced science courses (above Chemistry I or Physics I level). This is attributable to one fourth of seniors that completed either chemistry I or physics I (27.9%). An additional 7.6% completed Chemistry I *and* Physics I level and 6.5% reached highest level science courses in the advanced IV level.

Among the high school senior class of 2004, most students (42.1%) took foreign language courses 2 years or less. While 23.4% took none of foreign language course or had not completed course with passing grades, 25.9% had completed advanced foreign language study (i.e., year 3 or higher of a foreign language including 5.7% completed AP instruction). Finally, descriptive results showed that only 12.1% of the high school senior class of 2004 completed AP/IB English courses.

Stage I. Predictors of Course-taking Patterns

We estimated predictors of high school students' course-taking pattern in core subjects using a series of multi-level logistic models. The results are shown in Tables 1-4 for each subject and there are two results provided for each comparison; full and simplified models. The estimated effects of the predictor variables are reported as odds ratios.

Table 1 shows the results from the multilevel models on mathematics course-taking pattern. The most frequent category (middle academic level I: Algebra I) served as reference category. Model 1 to 5 predicted the change in the odds of completing highest to none (advanced academic level III, II, I, middle academic level II, and non/low academic level) compared to students who took their highest course as Algebra I, respectively. At the student-level, students' demographic characteristics (gender, ethnicity), family socio-economic status (SES) and students' previous achievement in math and reading were all significant predictors of math course-taking pattern. Among them, students' previous math achievement level is the most powerful predictor of math course-taking pattern. Controlling for students' SES and previous achievement, male students were less likely to take advanced courses compared to female students and Asian/Pacific Islander students were more likely to take advanced courses compared to their White peers. Specifically, the odds of completing the highest level (advanced level III) were almost five times larger for Asian/Pacific Islanders than Whites (OR = 4.77). Interestingly, controlling for SES, the odds of taking highest level (Calculus) were higher for African American students (OR = 2.74) and Hispanic students (OR = 1.74) compared to their White peers. Preliminary descriptive statistics showed a lower percentage of African American and Hispanic students that took advanced math courses compared to White students but this result suggests that lower rates for African American and Hispanic students can be explained in part by differences in their family backgrounds. At the school-level, mean SES, school structure (public school), the percent of students in college preparatory program, the percent of former graduate who went to 4-year colleges, and the proportion of student who received college entrance information from teachers and parents, and a ratio of full time guidance counselors were all significant predictors of math course-taking pattern. Among them, the percent of students in college preparatory program is the most powerful predictor at the school-level, followed by percent of former graduate who went to 4-year colleges.

Table 2 shows the results from the multi-level models on science course-taking pattern. The most frequent category (Chemistry I or Physics I) served as reference category. Model 1 to 6 predicted the change in the odds of completing highest to none (Advanced academic level IV, III, II, general biology, low academic level II, and non/low academic level I) compared to students who took their highest course as advanced academic level I (Chemistry I or Physics I), respectively (refer to science pipeline measure definition on p.7). At the student-level, students' previous math achievement level is the most powerful predictor of science course-taking pattern. Students' SES was also significantly related to their science course-taking pattern. Controlling for students' SES and previous achievement, Asian/Pacific Islander students were more likely to take advanced courses compared to their White peers. Specifically, the odds of completing the highest level (Advanced level IV) were three times larger for Asian/Pacific Islanders than Whites (OR = 3.14). Male students are more likely to finish below than general biology than the reference category (Chemistry I or Physics I) but the gender differences showed a complex pattern in their advanced science courses taken. Female students were more likely than male students to have completed the second highest level (Advanced level III: Chemistry II or Physics II or Advanced Biology) and male students were more likely than female students to have completed the highest (i.e., Advanced level IV) and the third highest level (Advanced level II: Chemistry I and Physics I). At the school-level, mean SES, school structure (public school), the ratio of student/ fulltime science teachers, the percent of former graduate who went to 4-year colleges, and the proportion of student who received college entrance information from teachers were significant predictors of science course-taking pattern. Specifically, students were more likely to complete the highest level (Advanced level IV) science course if they attended a high school where a higher proportion of former graduates went to 4-year college (OR= 1.31) and where there was a higher ratio of student/fulltime science teachers (OR = 1.18). Overall, students were more likely to complete below than general biology if they attended a public school or a high school with a lower proportion of former graduates who went to 4-year colleges.

Table 3 shows the results from the multi-level models on foreign language course-taking pattern. The most frequent category (two years or less instruction) served as the reference category. Model 1 to 4 predicted the change in the odds of completing highest to none (Advanced level III: AP instruction, Advanced level II, Advanced level I, and none) compared to students who took their highest course as the reference category (two years or less instruction), respectively (refer to the foreign language pipeline measure definition). At the student-level, students' previous math achievement level is the most powerful predictor of foreign language course-taking pattern. Student's SES was also significantly related to their course-taking pattern in foreign language. Controlling for student's SES and previous achievement, Hispanic and Asian/Pacific Islander students were more likely to take advanced courses compared to their White peers. Specifically, the odds of completing the highest level (Advanced level III: AP instruction) were five and half times larger for Hispanic than Whites (OR = 5.60). Female students were more likely than male students to have completed the foreign language courses across all levels. At the school-level, mean SES, school structure (public school), the ratio of student/fulltime foreign language teachers, the percent of students in college preparatory program, and the proportion of student who received college entrance information from counselors and teachers were significant predictors of foreign language course-taking pattern. Specifically, students were more likely to complete the highest level (Advanced level III: AP instruction) foreign language course if they attended a public school (OR = 2.85), a higher mean SES (OR = 1.77), a high school where a higher ratio of student/foreign language teachers (OR = 1.27), a higher percent of students in college preparatory program (OR = 1.65), and a higher proportion of student who received college entrance information from counselors (OR = 1.14) and teachers (OR = 1.27).

Table 4 shows the results from the multi-level models on English course-taking pattern. This model predicted the change in the odds of completing advanced English courses (AP/IB English courses) versus not completing any AP/IB English courses. At the student-level, students' previous achievement scores in both math and reading are powerful predictors of advanced English course-taking (OR = 2.67, 2.70, respectively). Students' SES was also significantly related to their advanced English course-taking (OR = 1.61). Controlling for student's SES and previous achievement, male students were less likely to take advanced English courses compared to female students (OR = 0.33) and Asian/Pacific Islander students were more likely to take advanced courses compared to their White peers (OR = 2.68). At the school-level, school structure (public school), the percent of students in college preparatory program, and the proportion of student who received college entrance information from teachers were significant predictors of advanced English course-taking pattern. Specifically, students were more likely to complete advanced English courses if they attended a public school (OR = 2.07), a higher percent of students in college preparatory program (OR = 1.46), and a higher proportion of students who received college entrance information from counselors (OR = 1.11) and teachers (OR = 1.15).

Stage II. Impact of Course-taking Patterns on Postsecondary education

By 2006, approximately two years after expected high school graduation date, seventy percent of spring 2002 sophomores had enrolled in a post-secondary institution; 39 percent of spring 2002 sophomores had enrolled in a 4-year college or university and 27 percent had enrolled in a 2-year institution. Among spring 2002 high school sophomores who had attended a post-secondary institution, approximately 15 percent entered college intending to study business/marketing, 17 percent entered college intending to study health, 15 percent entered college intending to study engineering/computer science/natural sciences/mathematics (see Table 5). Table 5 shows a detailed list of the selected student characteristics by their intended major. Course-taking patterns vary to a great extent across students' intended major. Approximately 30 percent of STEM major students and 18 percent of health major students finished the most advanced math course (i.e., Calculus), whereas only 3 percent of communication/journalism major students took Calculus. Science course-taking pattern showed similar discrepancy across student's intended major. Approximately 34 percent of STEM major students and 17.4 percent of health major students finished the most advanced science course, whereas only 2.6 percent of communication/journalism major students reached Chemistry II and Physics II level. Foreign language and English course-taking patterns are somewhat similar across student's intended major. Approximately 17% of STEM major students reached the highest level of foreign language course, followed by health (15.5%) and social sciences/social work (14.7%) major. Similarly, approximately 20% of STEM major students took advanced English courses, followed by social sciences/social work (14.4%) and health (14.1%) major.

Since students pursuing different major showed differential pattern in their course-taking in mathematics, science, foreign language, and English, we examined the relationships between high school students' course-taking pattern in core subjects and their post-secondary educational outcomes using a multinomial logistic models across their intended majors. We examined the relative effects of students' course-taking in core subjects on their college entrance to highly selective, moderately selective, and other 4-year colleges compared to 2-year or less colleges. The results are shown in Tables 6 across students' intended academic majors. The estimated effects of the predictor variables are reported as odds ratios.

Even after controlling for students' SES and previous achievement, students' math course-taking pattern was a significant predictor of their college entrance across all majors. For all ethnic groups, the likelihood of entering highly selective 4-year colleges compared to 2-year or less colleges was almost 15 times as high for students who completed the highest-level math course (i.e. Calculus). There were variations across academic major types, however, math course-taking pattern was one of the most powerful predictors across all majors especially for enrollment in highly selective 4-year colleges. Science course-taking on college entrance was significantly relevant for students majoring in health and STEM disciplines. For students who completed the high-level science courses (i.e., Chemistry II and Physics II), the odds of entering highly selective 4-year colleges compared to 2-year or less colleges were almost 4 times as high for health majors. Results indicated that foreign language course-taking had important effects on college entrance across all academic majors. The impact of advanced English course-taking on college entrance was highest for students majoring in *other*, followed by business, STEM, and health majors.

Discussion

This study provides important information about which student and school factor(s) significantly influences high school course-taking patterns. The identification of course-taking predictors that have significant effects has important implications for student learning as well as growth in academic achievement. Results lend support to the importance of students' academic background, especially the level of previous academic preparation. In addition, information regarding the influence of school characteristics such as background information (i.e., structure, resources, and student composition) and school process (i.e. practices and climate) on course-taking provides a better understanding of how schools affect student learning and preparation. Results also indicate the significance of course-taking patterns on post-secondary outcomes. Understanding characteristics that are beneficial to student achievement will help in reforming education programs. In particular, knowing which courses are most effective and relevant in determining the type of higher education institutions in which students will enroll may help educators, administrators, and parents strengthen academic preparation programs.

In examining the general characteristics of course-taking patterns in core-courses (i.e. mathematics, science, foreign language, and English) among the 2004 high school senior class, results showed that nearly half of the students who graduated had taken some level of advanced mathematics. In the sciences, over half of the graduates had completed some courses at the advanced level including nearly 10% who achieved the highest advanced level (level IV). Foreign language and English course-taking patterns, however, showed lower enrollment and/or completion rates than mathematics and science. In comparison to a previous national study (Planty et al., 2007), completion rate for advanced foreign language was comparable, but completion rate of advanced-level English was only 12.1% for this study, nearly twice lower than previous findings. The trends in course-taking patterns in this study illustrates that students are taking more advanced-level mathematic and science which is consistent with national studies conducted by the U.S. Department of Education (Dalton et al., 2007; Planty et al., 2007). The increase in course-taking in these two core academic courses reflects the demands of an economy that requires students to have more technical, quantitative, and analytical skills. As a result, schools and the education community are responding by increasing graduation requirements, as evident in the increase of course-taking (e.g., mathematics and science) in order to better prepare students (Council of Chief State School Offices, 2005). The trend presented in this study could be explained by a paradigm shift in education that emphasizes more mathematics and science to accommodate an increasingly specialized economy.

Our findings indicate a variety of student, family, and school factors that significantly predict students' course-taking in core academic subjects. Among the student factors, the most powerful predictors involve students' academic background, especially, their previous math achievement scores. This is consistent with previous studies that found high school advanced math enrollment and completion as one of the strongest predictors of college success (Adelman, 1999; 2006). Results also showed that there exist ethnic and gender gaps in their course-taking patterns. Asian Americans, in particular, were more likely to take advanced level courses across the four academic disciplines. This may be due to the heavy emphasis placed on education by Asian American families (Park & Chi, 1999). For Asian Americans, if academic success is viewed as a mechanism for ensuring future security and stability, it is reasonable to consider that students will participate in as many learning opportunities available to them. High educational expectations from parents and students individual expectations of success may account for the high number of advanced-level coursework completion in Asian Americans compared to other ethnic groups (i.e. Hispanic, Whites, African-Americans). Overall, females were more likely to complete advanced-level coursework. For example, females were more likely to take advanced math courses than males. This is in contrast to findings from previous studies indicating females earned fewer Carnegie units in the advanced mathematics sequence (Davenport, Davison, Kuang, Ding, Kim, & Kwak, 1998; Downer-Assaf, 1995). The discrepancy in results could be a function of changes in career choices to meet global economic standards. The shift towards more emphasis on technical knowledge and skills could be one of the possible explanations for gender differences in course-taking patterns, particularly, for mathematics. Xie and Shauman (2003) noted that the presence of women in engineering and science are on the slight increase in terms of degree obtainment and labor market representation. Whether or not our finding that more females are enrolled in advanced mathematics translates to persistent career objectives and attainment may be subject to further inquiry.

The types of school students attend also affect their course-taking pattern. After controlling for socio-economic composition, school structure and resources and school climate does affect students' course-taking pattern. In particular, the percent of students in college preparatory programs, percent of former graduates who went to 4-year colleges, and college entrance information were powerful predictors, indicating that a college-going environments play a significant role in students' course-taking in core subjects. These findings are similar to studies that have suggested that school organization, structure, and resources are critical components in influencing students' academic success (Benner et al., 2008; Carbonaro, 2005; Lee & Burkham, 2003; Jones et al., 2002; Martinez & Klopott, 2005; Rumberger & Palardy, 2005).

Understanding high school course-taking and factors that influence these patterns is consequential for students' post-secondary participation. The second phase of our analysis examined the status of postsecondary participation. In summary, course-taking patterns in core subjects (i.e. mathematics, science, foreign language, English) were significant predictors of post-secondary institution types. Among the four subjects, math course-taking pattern has by far the largest impact on students' post-secondary educational outcomes across all academic majors. Our findings are consistent with studies that suggest a relationship between course-taking in high school, especially mathematics, and positive college outcomes (Adelman 1999; 2006; Tyson et al., 2007). Variations in high school course-taking was also related to students' intended college majors. For example, students in STEM majors were more likely to have completed some advanced-level math compared to students in the humanities. This shows a pattern of continuity in subject-specific acquisition of skills during students' pre-college education that factor into their college experience. If students recognize their future academic interest at an early point in their high school career, their course-taking patterns could reflect the requirements of their intended majors. Thus, the education and training from high school to post-secondary education is relatively parallel and continuous, thereby, easing the transition for students from one level of education to another.

Strengths and Limitations

The major strengths of our study include the large nationally representative sample and the longitudinal design of study. The current study makes important contributions to the extant research in that we examined the course selection patterns of the four core academic subjects. Previous studies usually focused on mathematics and science but by expanding to the four core academic subjects, the current study provided rich information for educational researchers and parents. In particular, significant school-level predictors on core subject selection will provide valuable information for school administrators, staff, and faculty. In addition, results from the link between high school core subject selection and post-secondary enrollment will be useful information for school counselors and educational researchers.

This study also has several limitations. Due to data availability, the current study could only examine how high school students' course-taking patterns influence students' post-secondary enrollment. Further studies are needed to investigate how course-taking patterns are related to post-secondary academic outcomes such as college GPA and bachelor's degree attainment. The current study focused on exploring effects of a wide range of school factors. Further studies are recommended to explore student social-psychological aspects as well as their attitudes and beliefs on core academic subject taking patterns. Also, advanced course-taking patterns vary by gender and ethnicity. Therefore, differential effects of student- and school-level predictors on outcome across gender and ethnicity will be further explored.

Implications and conclusion

These findings from this study is useful for informing policymakers, higher education administrators, schools, and parents about the experiences of contemporary American youth transitioning out of high school. Understanding course-taking patterns and factors of influence as it impact post-secondary success is relevant for developing and maintaining intense, rigorous, and challenging curriculum. The benefits for students that experience an academically advanced curriculum are that they will be well-prepared and competitive for future academic or employment opportunities. The implications also extend to schools providing students with a learning environment that is conducive to optimal performance. For example, educators need to account for the organizational structure and climate of schools in determining resources, support networks, and materials that sustain and accelerate learning opportunities. The results of this study could also inform changes in communication between the different levels of education. Within the K-12 system, schools can use information from students' course-taking patterns to modify college preparation programs to focus on more key advanced-level course-work that help students succeed in college. From that foundation, high schools and post-secondary institutions can better cooperate and find parallels in their respective curriculum to create effective pathways to college.

This study also has important implications for parents. Course-taking patterns does not alone account for student success. There are a variety of psycho-social and economic factors involved in the academic choices students make. Students play a central role in the path to college, however, parents can support their success by becoming more involved in helping students choose course-work that best serves their academic goals. In addition, recognizing that background characteristics such as gender, SES, and previous achievement influence academic pathways, parents, students, and school can work together to find holistic academic preparation programs that can accommodate the personal and academic needs of students. The task of providing youth with quality education and training rests on the partnership of multiple sources.

Therefore, the information from this study is particularly useful for policymakers, administrators, educators, and parents as they work towards creating rigorous and comprehensive education programs designed to adequately prepare students for postsecondary education goals.

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Table 1

Results of Multilevel models of Mathematics Course-taking

	Model 1 (Advanced III: Calculus)				Model 2 (Advanced II: Pre-calculus)				Model 3 (Advanced I: Trigonometry/Algebra III)				Model 4 (Middle II: Algebra II)				Model 5 (Non/low academic)			
	Full		Simplified		Full		Simplified		Full		Simplified		Full		Simplified		Full		Simplified	
	Exp (B)	p	Exp (B)	p	Exp (B)	p	Exp (B)	p	Exp (B)	p	Exp (B)	p	Exp (B)	p	Exp (B)	p	Exp (B)	p	Exp (B)	p
Student-level																				
Gender (male)	0.57	***	0.44	***	0.57	***	0.50	***	0.66	***	0.63	***	0.71	***	0.72	***	1.37	***	1.37	**
Asian	4.60	***	4.77	***	2.16	***	2.34	***	1.27	†	1.46	†	1.37		1.27		0.63	†	0.52	*
African American	1.85	***	2.74	***	1.28	*	2.32	***	1.16	***	2.10	***	1.24	***	1.86	***	0.98		0.80	
Hispanic	1.32	*	1.74	*	1.04		1.54	*	0.84		1.03		0.92		1.18		0.62	**	0.47	***
Other	1.04		0.92		0.88		0.81		0.85	†	0.73	†	1.00		0.95		1.06		0.73	
SES	1.53	***	1.81	***	1.38	***	1.57	***	1.24	***	1.36	***	1.17	***	1.20	***	0.88	*	0.85	**
Math	8.91	***	9.54	***	3.54	***	5.20	***	1.86	***	2.39	***	1.65	***	1.77	***	0.53	***	0.51	***
Reading	1.38	***	1.56	***	1.37	***	1.38	***	1.37	***	1.42	***	1.22	***	1.23	***	0.89	†	0.83	*
School-level																				
Mean SES	1.07				0.96				0.91				0.78	**			1.15			
Public	0.77		0.77		0.71	†	0.72	†	0.70		0.73		0.60	*	0.66	*	4.17	***	3.96	***
4-yr college	1.29	*	1.34	**	1.26	**	1.24	**	1.32	*	1.28	**	1.14	†	1.06		0.90		0.94	
College prep	1.55	***	1.58	***	1.52	***	1.51	***	1.52	***	1.50	***	1.20	*	1.16	*	1.10		1.12	
Counselors Help	1.02				0.97				1.00				0.99				1.03			
Teachers Help	1.14	†	1.14	†	1.10		1.10		0.95		0.96		0.95		0.98		1.05		1.04	
Parents Help	1.02	*	1.04	*	1.19	*	1.17	*	1.20	*	1.17	†	1.16	*	1.08	*	1.01		1.06	
Full-time teachers	0.99		0.99		1.06	*	1.06	*	1.09	*	1.09	*	1.05		0.96		0.97		0.96	
Full-time counselors	1.10	*	1.11	*	1.01	*	1.01	*	1.04	*	1.04	*	1.05		1.04		1.07		1.07	

Note. Reference category = Middle academic level I: Algebra I, † $p < .10$, *$p < .05$, **$p < .01$, ***$p < .001$.

Table 2

Results of Multilevel models of Science Course-taking

	Model 1 (Advanced level IV: Chem II & Phys II)				Model 2 (Advanced level III: Chem II/Phys II)				Model 3 (Advanced level II: Chem I & Phys I)				Model 4 (Middle academic level: General biology)				Model 5 (Low academic level II)				Model 6 (Non/low academic level I)			
	Full		Simplified		Full		Simplified		Full		Simplified		Full		Simplified		Full		Simplified		Full		Simplified	
	Exp (B)	p	Exp (B)	p	Exp (B)	p	Exp (B)	p	Exp (B)	p	Exp (B)	p	Exp (B)	p	Exp (B)	p	Exp (B)	p	Exp (B)	p	Exp (B)	p	Exp (B)	p
Student-level																								
Gender (male)	1.17	*	1.05	*	0.81	**	0.83	*	1.17	**	1.18	*	1.45	***	1.44	***	1.61	***	1.64	***	2.28	***	2.14	***
Asian	2.79	***	3.14	***	1.59	**	1.61	*	1.31	†	1.50	*	0.76	*	0.46	***	0.56	†	0.35	**	0.61		0.81	
African American	1.41	*	1.15	*	0.82		0.72		1.10		1.12		0.90	*	0.62	***	0.62	**	0.25	***	0.90	*	0.62	*
Hispanic	1.14		0.78		1.07	*	1.07	*	1.19		1.06		0.99	*	0.70	**	0.63	*	0.45	**	1.08	†	0.67	†
Other	0.99		1.22		0.82		0.86		1.00		1.17		0.88		0.95		1.48	†	1.27		1.12		0.78	
SES	1.24	***	1.25	***	1.12	**	1.09	†	1.11	**	1.08	*	0.85	***	0.79	***	0.77	***	0.69	***	0.75	***	0.63	***
Math	2.80	***	3.51	***	1.24	***	1.24	**	1.62	***	1.80	***	0.63	***	0.63	***	0.49	***	0.48	***	0.43	***	0.43	***
Reading	1.14	*	1.27	**	1.25	***	1.24	***	0.99		1.06		0.81	***	0.74	***	0.62	***	0.59	***	0.67	***	0.56	***
School-level																								
Mean SES	1.40	*	1.28	†	0.81	†	0.80		1.31	*	1.28	*	0.95		0.94		1.15		1.08		1.35		1.24	
Public	1.34		1.34		1.03		1.04		0.87		0.89		1.23	†	1.35	†	1.95	†	1.77	†	8.10	***	9.41	***
4-yr college	1.28	*	1.31	*	1.12	*	1.12	*	1.05	*	1.07	*	0.87	†	0.87	*	0.76	*	0.74	**	0.62	***	0.61	***
College prep	1.04				0.95				0.97				0.91				1.00				0.79	†		
Counselors Help	1.05				1.05				1.12	†			1.12	†			1.13				1.23	*		
Teachers Help	1.16	†	1.11	*	1.17	†	1.17	*	0.97		0.97		1.00		1.02		1.02		1.01		0.87		0.87	
Parents Help	0.81	*			0.99				0.96				1.01				0.86				0.90			
Full-time teachers	1.22	†	1.18	*	1.01		0.99		1.15	*	1.14	*	1.00		1.00		0.89		0.94		0.90		0.90	
Full-time counselors	0.92				0.99				0.97				0.97				1.12	†			1.01			

Note. Reference category = Advanced level I (Chemistry I or Physics I), † $p < .10$, *$p < .05$, **$p < .01$, ***$p < .001$.

Table 3

Results of Multilevel models of Foreign Language Course-taking

	Model 1 (Advanced level III:AP Instruction)				Model 2 (Advanced level II: Year 4 or less)				Model 3 (Advanced level I: Year 3 or less)				Model 4 (None)			
	Full		Simplified		Full		Simplified		Full		Simplified		Full		Simplified	
	Exp (B)	p	Exp (B)	p	Exp (B)	p	Exp (B)	p	Exp (B)	p	Exp (B)	p	Exp (B)	p	Exp (B)	p
Student-level																
Gender (male)	0.56	***	0.41	***	0.60	***	0.48	***	0.72	***	0.60	***	1.69	***	1.74	***
Asian	1.10	†	1.44	†	1.73	***	1.18	***	1.45	*	1.29	†	1.43		1.80	
African American	1.01		0.86		1.40	**	0.85		1.07		1.12		0.74	**	0.63	***
Hispanic	3.24	***	5.60	***	2.43	***	1.60	**	1.33	**	1.47	**	0.91		0.63	***
Other	0.73		0.67		0.92		0.69	†	1.09		0.87		1.18		1.38	*
SES	1.06		1.13	†	1.24	***	1.25	***	1.11	**	1.12	**	0.82	***	0.74	***
Math	1.86	***	2.44	***	1.50	***	1.86	***	1.34	****	1.62	***	0.61	***	0.61	***
Reading	1.34	***	1.60	***	1.37	***	1.53	***	1.18	***	1.27	***	0.70	***	0.66	***
School-level																
Mean SES	1.84	***	1.77	***	1.19	***	1.42	***	1.19	*	1.40	***	1.19	*	1.00	
Public	2.75	***	2.85	***	1.19		1.07		1.53	*	1.32	†	1.36		1.41	
4-yr college	1.06				1.35	*			1.19	*			0.81	**		
College prep	1.57	***	1.65	***	1.12	*	1.24	*	1.31	***	1.31	***	0.84	*	0.80	**
Counselors Help	1.16	*	1.14	*	1.12		1.15	†	1.03		1.07		1.00		0.99	
Teachers Help	1.38	***	1.27	**	0.97		0.92		1.05	†	1.06	†	1.13	*	1.10	†
Parents Help	0.89				1.10				1.14				0.87	*		
Full-time teachers	1.32	***	1.27	***	1.38	***	1.36	***	1.23	***	1.25	***	1.00		1.01	
Full-time counselors	0.95				0.99				1.06				1.05			

Note. Reference category = 2 Years or less instruction, † $p < .10$, *$p < .05$, **$p < .01$, ***$p < .001$.

Table 4

Results of Multilevel models of Advanced English Course-taking

	Full		Simplified	
	Exp (B)	p	Exp (B)	p
Student-level				
Gender (male)	0.35	***	0.33	***
Asian	2.50	***	2.68	***
African American	1.07		1.17	
Hispanic	0.82		0.95	
Other	0.88		1.11	
SES	1.55	***	1.61	***
Math	2.75	***	2.67	***
Reading	2.65	***	2.70	***
School-level				
Mean SES	1.00			
Public	1.96	**	2.07	***
4-yr college	1.05			
College prep	1.44	***	1.46	***
Counselors Help	1.13	†	1.11	*
Teachers Help	1.22	**	1.15	*
Parents Help	0.95			
Full-time teachers	0.91			
Full-time counselors	0.99			

Note. † $p < .10$, *$p < .05$, **$p < .01$, ***$p < .001$.

Table 5

Percentage distribution of high school graduates by major and select student characteristics

Characteristic	Business/ marketing	Health	Education/ teaching	Engineering/ computer science/natural sciences/ mathematics	Social sciences/ social work	Architecture/ design/ urban planning	Fine arts/ humanities	Communi-cations/ journalism	Other	Don't know/ undecided
Total	15.1	17.0	7.5	14.8	9.1	1.9	6.9	2.7	18.5	6.5
Sex										
Female	12.5	24.6	10.6	7.0	10.7	1.7	7.3	3.3	15.5	6.7
Male	18.2	8.0	3.8	24.0	7.3	2.1	6.3	2.1	22.0	6.2
Race/ethnicity										
American Indian	8.8	14.6	3.5	17.7	16.4	1.1	2.4	0.0	23.9	11.6
Asian or Pacific American	18.3	24.7	2.1	19.9	7.4	2.3	6.2	1.8	9.7	7.7
African American	16.5	21.6	5.7	17.7	9.7	0.7	4.7	3.0	16.2	4.3
Hispanic	12.3	18.9	6.6	12.2	10.1	2.0	3.6	2.3	24.4	7.6
White	15.4	15.1	8.6	14.3	8.9	2.0	7.8	2.8	18.4	6.7
SES										
Low	12.6	25.1	6.9	12.7	8.0	2.0	3.1	1.4	22.2	5.9
Second	14.2	19.1	8.0	13.3	8.0	1.7	5.4	2.3	21.3	6.6
Third	15.7	14.3	7.8	13.9	9.2	1.7	7.5	3.5	19.9	6.5
Highest	16.8	13.3	7.2	17.8	10.6	2.0	9.6	3.1	13.0	6.6
Math										
Pre-Algebra or lower	10.5	16.0	5.9	15.5	6.2	0.3	4.6	1.3	30.6	9.2
Algebra I/geometry	11.9	17.9	6.7	8.6	9.2	1.7	5.2	1.3	30.8	6.7
Algebra II	15.4	18.5	7.7	8.0	8.9	1.2	6.8	3.7	22.8	7.1
Trigonometry, Algebra III	18.1	16.5	8.9	13.5	9.5	1.3	7.0	2.1	15.5	7.7
Pre-calculus	16.5	14.9	8.5	16.6	10.7	3.3	8.7	3.2	12.5	5.1
Calculus	13.1	18.0	5.3	30.3	7.9	1.9	7.0	2.9	8.0	5.7
Science										
Primary	8.6	15.1	9.5	14.2	6.1	0.7	4.2	1.1	30.9	9.6
Secondary	18.8	10.8	4.8	12.5	6.9	4.9	4.8	0.8	28.8	6.8
General biology	15.4	16.4	7.3	8.7	8.0	1.7	6.3	1.9	27.4	6.9
Chemistry 1 or physics 1	16.1	17.8	8.0	11.4	9.9	1.5	7.2	3.6	17.6	6.9
Chemistry 1 and physics 1	16.2	14.4	8.8	17.9	10.3	1.8	7.0	2.8	14.4	6.4
Chemistry 2 or physics 2	13.2	22.7	7.1	15.2	10.5	1.7	8.3	2.1	14.2	4.9

Chemistry and physics	10.9	17.4	4.1	34.4	7.3	2.8	7.1	2.6	7.5	6.0
Foreign Language										
None	12.7	16.2	5.8	12.5	7.9	1.7	5.5	0.8	30.1	6.7
Year 2 or less	16.4	18.2	7.3	14.2	7.8	1.7	6.5	2.4	18.9	6.5
Year 3	15.6	17.0	8.4	17.1	9.3	1.7	6.8	4.0	13.7	6.5
Year 4	12.8	14.4	9.6	14.5	13.5	1.9	8.4	3.7	12.3	9.0
AP	12.2	15.5	7.4	17.2	14.7	2.7	10.5	3.6	11.9	4.3
English										
AP Instruction	11.4	14.1	6.7	19.6	14.4	2.4	12.7	4.2	9.0	5.4
No	15.8	17.7	7.7	13.7	8.1	1.7	5.7	2.4	20.5	6.8

Table 6

Results of Multinomial Logistic models of Coursetaking By Major

	All		Business		Health		STEM		Other	
Highest course	*Exp (B)*	p	*Exp (B)*	p	*Exp (B)*	p	*Exp (B)*	p	*Exp (B)*	P
Highly selective										
Math										
Calculus	15.03	***	15.18	*	11.82	**	15.64	***	13.60	**
Pre-calculus	9.21	***	13.74	*	4.44	*	14.73	***	3.78	*
Trigonometry	3.74	**	2.72		1.75		6.23	**	2.46	
Algebra II	2.77	*	2.44		1.13		5.42	**	0.90	
Algebra I / Geometry (Ref)	-		-		-		-		-	
Pre-algebra or lower	1.60		0.00		0.00		1.51		3.22	
Science										
Chem 2 and phys 2	1.84	**	1.06		3.78	*	2.39	*	1.48	
Chem 2/phys 2/ Adv Bio	1.13		1.30		1.13		1.21		0.98	
Chem 1 and phys 1	1.45	*	2.75	**	1.38		1.00		1.34	
Chem 1 or phys 1 (Ref)	-		-		-		-		-	
General biology	0.48	**	0.51		0.45		0.30	†	0.53	*
Secondary physical science	0.52		0.00		0.00		0.62		0.40	
Primary physical or less	0.13	†	0.00		0.00		0.17		0.11	
Foreign Language										
AP Instruction	3.86	***	1.82		3.71	*	2.89	*	4.62	***
Year 4 or less	4.44	***	12.68	***	4.81	**	8.17	***	3.63	***
Year 3 or less	1.90	***	2.80	**	2.83	**	0.73		1.90	**
Year 2 or less (Ref)	-		-		-		-		-	
None	1.13		0.94		2.12		1.01		0.98	
English										
AP/IB courses	3.39	***	2.72	*	2.05	†	2.56	*	4.39	***
None (Ref)	-		-		-		-		-	
SES	1.99	***	2.83	***	2.12	***	1.31		1.98	***
Math	1.58	***	2.01	**	1.82	*	1.49	†	1.35	**
Reading	1.56	***	1.53	†	1.33		1.46	†	1.77	***

Moderately selective										
Math										
Calculus	5.87	***	8.76	***	34.47	***	6.55	**	2.66	***
Pre-calculus	5.16	***	12.68	***	11.70	***	2.83	*	4.10	***
Trigonometry	3.60	***	6.82	***	8.33	***	2.32	†	2.89	***
Algebra II	2.34	***	3.32	*	5.16	***	1.82		2.03	***
Algebra I / Geometry (Ref)	-		-		-		-		-	
Pre-algebra or lower	1.72		4.14		1.63		0.50		2.03	
Science										
Chem 2 and phys 2	1.16		1.15		1.70	*	2.16	*	0.73	
Chem 2/phys 2/ Adv Bio	1.09		1.35		1.06	†	1.17		1.02	
Chem 1 and phys 1	1.17		1.20	*	1.67		1.02		1.15	
Chem 1 or phys 1 (Ref)	-		-		-		-		-	
General biology	0.59	**	0.54		0.85		0.44	†	0.58	**
Secondary physical science	0.28	**	1.08		0.00		0.00		0.24	*
Primary physical or less	0.12	**	0.00		0.00		0.19		0.13	**
Foreign Language										
AP Instruction	1.30		1.32		1.19		1.02		1.35	
Year 4 or less	1.90	***	3.67	**	1.95		3.35	†	1.75	**
Year 3 or less	1.21		1.22		0.85		0.48		1.60	*
Year 2 or less (Ref)	-		-		-		-		-	
None	0.61	**	0.42	*	0.74		0.38	*	0.66	*
English										
AP/IB courses	1.93	***	1.68		1.45		1.35		2.36	***
None (Ref)	-		-		-		-		-	
SES	1.45	***	1.73	***	1.63	***	1.00		1.42	***
Math	1.22	*	1.35		1.30		1.22		1.10	
Reading	1.33	***	1.01		1.30		1.33		1.46	***
Other 4year colleges										
Math										
Calculus	3.67	***	3.63	*	4.53	*	3.94	*	2.27	*
Pre-calculus	3.03	***	4.66	**	3.86	**	1.42		3.00	***

Trigonometry	1.90	**	2.05		2.36	†	0.94		1.99	**
Algebra II	1.77	**	1.42		1.86		0.73		2.25	***
Algebra I / Geometry (Ref)	-		-		-		-		-	
Pre-algebra or lower	0.97		1.08		0.70		0.57		1.16	
Science										
Chem 2 and phys 2	0.65		0.21		0.65		0.64		0.63	
Chem 2/phys 2/ Adv Bio	0.72		0.64		1.01		0.33		0.80	
Chem 1 and phys 1	0.78		1.06		0.85		0.50		0.77	
Chem 1 or phys 1 (Ref)	-		-		-		-		-	
General biology	0.68	**	0.65		0.86		0.63		0.66	*
Secondary physical science	0.79		2.10		0.83		0.09		0.66	
Primary physical or less	0.75		0.00		0.59		0.26	*	1.07	
Foreign Language										
AP Instruction	1.08		0.88		2.18		0.97		0.96	
Year 4 or less	1.51	†	2.59		1.99		1.77		1.55	†
Year 3 or less	0.87		0.70		1.05		0.61		0.90	
Year 2 or less (Ref)	-		-		-		-		-	
None	0.96		0.66		1.88		0.51	†	0.95	
English										
AP/IB courses	1.57	*	1.35		1.42		0.71		2.10	**
None (Ref)	-		-		-		-		-	
SES	1.12	*	1.24		1.18		0.90		1.12	
Math	0.82	*	0.50	**	1.13		0.74		0.82	
Reading	1.10	†	1.33		0.90		1.46	†	1.13	

Note. † $p < .10$, *$p < .05$, **$p < .01$, ***$p < .001$