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Rigorous Curriculum and SAT

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Abstract

The main purposes of this study are to investigate the relation between course-taking pattern and the SAT score, and examine the invariance of this relation across subgroups. In addition, we are also going to verify the accuracy of self-reported information from the SAT Questionnaire by examining the actual high school transcripts, and build the link between SAT and the achievement by correlating SAT scores with state assessment scores. Previous studies suggested that taking rigorous courses should lead to higher achievement test scores. If the SAT score is validated to be a measure of achievement and a function of high school course-taking behaviors regardless of students' gender, socioeconomic status (SES) and ethnicity, every student should be provided with equal opportunity for rigorous curriculum. Students will also have incentives to focus on their course study to attain success in college admission and curriculum.

Introduction

The critical need of today's education is to impart basic skills to the students. It is the public's essential concern about whether students are making optimal achievements in school and how to prepare them for future careers. From a global perspective, American high school students may be less competitive compared with their international peers in mathematics and science. The Program for International Student Assessment (PISA) reported that 15-year-old students in the United States ranked 24th out of 29 countries in problem solving and mathematics literacy (Lemke, Sen, Pahlke, Partelow, Miller, Williams, Kastberg, & Jocelyn, 2004). In addition, it is of public interest to address the persistent gaps in achievement between subgroups including racial/ethnic, gender, and socioeconomic status. Actions need to be taken to improve the quality and equality of education.

In response to these concerns, panels, commissions, and policy makers at the decision making level have investigated the problems, put forth specific proposals, and implemented legislations for improvement. The majority of the policies shift curriculum emphasis and class hours away from general education and vocational education to required courses in mathematics, science and computer science (NCES, 1985). The general trend is that American high school students have been taking a greater number of academic courses and are gaining in achievement, which has been consistently shown by results of High School Transcript Studies and some other research between 1982 and 2004 (Legum, Caldwell, Davis, Haynes, Hill, Litavecz, Rizzo, Rust, Vo, & Gorman, 1988; Levesque, Lauen, Teitelbaum, Alt, & Librera, 2000; National Commission on Excellence in Education, 1983; Perkins, Kleiner, Roey, & Brown, 2004; U.S. Department of Education, 2000). Camara, Kobrin, and Sathy (2005) pointed out that the curriculum might be an important factor to improve achievement. It is also possible that by providing equally rigorous and high quality courses, the differences between the subgroups on achievements can be narrowed. Since enhancing the number of specific courses is also associated with more financial resources and teacher pool expansion, further research is necessary to explain the relation between course-taking pattern and the achievement.

Previous studies (e.g., Kobrin, Sathy & Shaw, 2006) on the factors associated with students' achievement have focused on socioeconomic status (SES) to a large extent, which has somehow obscured the possible association between the course-taking pattern and the achievement. The High School Transcript Study reported the relation between course-taking patterns and posterior scores of NAEP assessment, but with matrix sampling design of NAEP tests, there is some uncertainty about the correlations and their interpretations.

SAT scores are used as the indicator for achievement outcomes in this study. SAT is one of the most widely used standardized tests for college admissions and has long being recognized as a measure for college readiness and a predictor for college success (Kobrin, Patterson, Shaw, Mattern, & Barbuti, 2008). Although SAT is not created directly as an achievement test, it is expected to be developed into curriculum-based achievement tests that are more closely linked to high school curriculum, which is an important school experience that leads to college readiness (NACAC, 2008). We hope to gain evidence from this study that SAT also measures the achievement and SAT is reflective of students' course-taking behaviors at high school. In that case, students will be conditioned to focus on their course material study in high school rather than test-taking skills by attending expensive extracurricular test preparatory courses if they want to do well on admission tests and succeed in college study (NACAC, 2008).

The main purposes of this study are to (1) investigate the relation between course-taking pattern and the SAT score which is an indicator of the college readiness, and (2) examine the invariance of this relation across subgroups. We are also going to (3) verify the accuracy of self-reported information from the SAT Questionnaire by examining the actual high school transcripts. In addition, (4) we will investigate to what extent SAT measures the achievement through comparison with state assessment scores.

Literature Review

Course-taking patterns and achievement

Course-taking is the major activity of students in school, and is believed to be closely related to achievement. The study on course-taking is worthwhile because it is possible to influence course-taking through educational policy, counseling, and advising students and parents, which in turn may affect achievement (Davenport et al., 1998). Many studies on course-taking have addressed its influences on high school achievement outcomes. By using data from the ACT assessments, McClure (1998) studied the math course-taking behavior of high school students and found that students who took more college preparatory math courses also scored higher on ACT math tests. Likewise, treating the SAT score as an outcome variable, Brody and Benbow (1990) reported that taking rigorous science and math courses throughout the high school years resulted in higher scores in SAT math. An NCES report (1996) which was based on the data of every state and jurisdiction that participated in the 1992 NAEP assessment revealed that eighth graders who were enrolled in algebra courses had consistently higher average proficiency than students enrolled in pre-algebra, who in turn had higher proficiency than students taking general eighth-grade mathematics courses. Results from other large-scale assessment studies also suggested a similar influence of course-taking on high school achievement (Chaney, Burgdorf, & Atash, 1997; Trusty, 2002).

However, the tendency that higher performing students take a larger number of and more difficult courses may be interpreted in at least two ways. More course taking may lead to higher achievement, or students who are more proficient are likely to take more advanced classes. Longitudinal data analysis allows for investigating changes in proficiency while controlling the initial performance levels (NCES, 1997). Longitudinal research on the relations between course-taking and achievement has been focusing on math and sciences, since course-taking is generally a powerful indicator of math and science achievement. It had been observed that students who took more advanced mathematics courses show greater gains than those taking mostly basic courses (NCES, 1995). Further investigation provided insightful evidence that students in the advanced courses, who already had high levels of proficiency in basic skills at the beginning of high school, made larger gains on test items requiring conceptual understanding and problem solving skills. It was pointed out that significant growth in these areas did not occur until students moved into the pre-calculus level of coursework (Garmoran, Porter, Smithson, & White, 1997).

In regard to science, it was also found that students who took higher level science courses were more likely to gain in science proficiency level than those who did not. As with mathematics, this relationship was especially salient for students who started at the top level of proficiency in the eighth grade. Among students who started at the lowest level of proficiency in the eighth grade, this relationship was relatively weak. However, students' chances of gaining in proficiency were also related to the number of science courses that they had taken (NCES, 1997).

A 4-year period study with the 1988 eighth-graders unveiled more details with respect to the complex relationship between course taking and the achievement. It was found that the rigor of course taking was highly related to the likelihood of increasing in science proficiency level even after taking into account a number of other factors, including the number of science courses taken. Among students at similar levels of science proficiency in 1988, those who took physics in high school were more likely to demonstrate a gain in science proficiency level than those who did not. Except for students with low levels of eighth-grade science proficiency, those who took chemistry were more likely to increase than those who took neither chemistry nor physics. Similarly, except for students who started at the lowest level, those who said that they were in an academic curriculum were more likely to increase than those who said they were in another type of curriculum (NCES, 1997). Science course taking, therefore, is important for students at all levels of initial science proficiency.

Measures of course-taking patterns

There are various ways to measure the course-taking patterns. For example, one way is to measure the number of credits a student has completed in different subjects. Another method is to measure the highest level of coursework completed in different subjects (e.g., whether a student's most academically challenging mathematics course was algebra I, trigonometry, or calculus). However, validation studies have indicated that the highest level of academic course completed by students and their scores on tests of academic achievement were significantly different (Chaney, Burgdorf, & Atash, 1997).To study the overall course-taking pattern, one can calculate the percentage of students who have completed those courses. To capture the course-taking experiences of high school students in terms of the subject content, the measure called academic "pipeline" has been developed to organize courses in English, science, mathematics, and foreign language into levels, based on the normal progression and difficulty of courses within these subject areas (Burkam 2003; Burkam and Lee 2003). Based on these methods, analysts have created different measures to categorize high school course-taking (NCES, 2007).

For example, the course-taking data used in the transcript analysis for a report on the national educational condition (NCES, 2007) were organized according to the Classification of Secondary School Courses (CSSC) and the Secondary School Taxonomy (SST). All courses in a student's transcript were coded with a CSSC value after checking the course catalogs from the student's high school and then assigning to course groups. Academic levels in each subject area were formed using SST. Course credits were expressed in Carnegie units which is a standard of measurement used for the secondary curriculum system that is equivalent to the completion of a course of 40 minutes per day for one school year.

Information from the transcript study based on the measurements described above is a reliable source but not perfect. The classifications allow the comparison between different schools or graduating classes, as well as the inference that high school graduates who have completed courses at the higher levels may have more advanced learning experiences than those having completed courses at lower levels. However, one significant limitation is that there is a large variation in terms of the content and instructional methods taught by teachers within and across schools for a course that has the same transcript code. The course-taking measures do not represent differences in content or academic challenge of the courses taken by individual students. They may include only the courses completed but not the courses attempted. Some subjects, such as English language and literature, do not neatly fit into an ordered hierarchical framework (NCES, 2007).

Overall trends in course-taking

The NCES studies show the trend and changes of course-taking patterns. Over the past 20 years, the focus of course-taking had been shifted from general education and vocational education to mathematics and science education. American high school students were taking an increasing number of academic courses, particularly in mathematics and science. In addition, they were increasingly likely to complete advanced academic coursework in these subjects before graduation from high school. The upward movement in course-taking occurred not only among high school graduates nationwide but also in all student subgroups examined, including those identified by sex, race/ethnicity, SES, and school sector (Dalton, Ingels, Downing, & Bozick, 2007). The trend of the course-taking was also characterized by the growth in the average number of credits required by states. The requirements for earning a high school diploma have become more rigorous (NCES, 2007).

The average number of credits earned by high school had increased from 21.7 credits in 1982 to 25.8 credits in 2004. Viewing the change of credits in each subject separately between 1982 and 2004, the average credits earned by graduates had increased from 4.0 to 4.3 in English, from 2.7 to 3.6 in mathematics, and from 2.2 to 3.2 in science. As for college-preparatory course-taking during the same period, the average number of credits that graduates earned in mathematics increased from 1.9 to 3.1, from 0.4 to 0.7 in chemistry and from 0.2 to 0.4 in physics. Besides, credits earned in history/social studies, arts and foreign languages also increased. The only subject in which the credits earned had decreased was vocational course-taking. By 2004, the proportion of high school students who had completed advanced science coursework (i.e. at least one course classified as more challenging than biology) had increased from 35 percent in 1982 to 68 percent. Similarly, the proportion of high school graduates completing advanced English language courses had also increased from about 13 percent to 33 percent. In the same period, the percentage of high school graduates who had completed 75-100 percent of their English courses at the honors level increased from 4 to 16 percent. In 2004, the percentage of graduates completing advanced foreign language study had more than doubled since1982. The total number of students taking AP examinations had also more than doubled between 1997 and 2005 (NCES, 2007; Dalton, et al., 2007).

Many states have implemented minimum requirements on the number and types of courses that students take in high school and that are necessary to pass the standardized state tests. Up to 2004, 17 states required specific courses in math and 23 states required specific courses in science for graduation (Council of Chief State School Officers [CCSSO], 2005). From 1987 to 2004, the number of states that require 2.5 credits in mathematics had risen from 12 to 26, and the number of states that required at least 2.5 credits in science had increased from 6 to 23 (CCSSO, 2005). Up to 2007, public high school students in 37 states were required to complete at least 20 credits (in Carnegie units); 8 states required fewer than 20 credits; course-taking requirements were specified locally in the other states. Of all the states with explicit course-taking requirements, 37 required 4 or more years of English, 31 required 3 or more years of social studies, 27 required 3 or more years of mathematics, and 23 required 3 or more years of science before graduation (NCES, 2007).

Subgroup distribution of course-taking patterns

The course-taking patterns are differentially distributed among the subgroups identified by gender, ethnicity, SES and school sector. Course-taking patterns vary by gender and ethnicity over time and within each year. However, some of the differentiations are consistent. For example, substantially larger proportions of white and Asian/Pacific Islander students were taking algebra than black and Hispanic students; Larger proportions of students in advantaged urban areas and private schools were taking algebra, and the difference was particularly significant at eighth grade (NCES, 1996; Lee, Chow-Hoy, Burkam, Geverdt, & Smerdon, 1998; Davenport et al., 1998).

With respect to gender differences in course-taking, in 1982, females earned 0.35 more total credits than males on average, but by 2004, no measurable differences were detected. In 1982, males earned an average of 0.14 more credits in both mathematics and science than females, but that difference is also insignificant by 2004. In the case of advanced English and foreign language, through 1998, and 2000 to 2004, female graduates were more likely than male graduates to have completed advanced English and foreign language study (NCES, 2007). In some early studies (see Davenport et al., 1998), boys are found to have higher frequency of taking advanced mathematics courses in high school as compared with girls, and researchers attributed this difference to the tendency for females to value language-related skills and tasks more and men to value mathematics-related skills and tasks more. However, that difference between genders in advanced math course-taking lessened in the 1990s. Patterns among males and females in advanced science course-taking generally remained the same from 1982 to 2004. Despite some narrowing differences, other disparities remained among gender subgroups and occasionally widened over time, for instance, a gap in favor of females over males in completing chemistry I or physics I. In 1982, 15 percent each of males and females exited the pipeline at chemistry I or physics I. In 1997, girls were less likely than boys to take physics, but girls were more likely than boys to take biology and chemistry (NCES, 2000a).Yet by 2004, 37 percent of females were taking chemistry I or physics I prior to graduating from high school, but only 30 percent of males were doing so. However, no differences were detected in the completion rates for the two most advanced levels of science courses (chemistry II, physics II) (Dalton, et al., 2007).

Course taking in high school also differs for racial-ethnic groups. In 1982, Asian/Pacific Islander graduates earned more total credits than graduates of any other race/ethnicity. In contrast, by 2004, these differences were not significant. However, in both 1982 and 2004, Asian/Pacific Islander graduates earned more credits in both mathematics and science than did graduates of any other race/ethnicity. In addition, White and Asian graduates were more likely to enroll in and complete advanced mathematics and science courses than their Black, Hispanic, and American Indian peers. Asian graduates, in particular, continued their advantage over all other groups in taking pre-calculus; calculus; and chemistry II, physics II, or advanced biology. It is also noteworthy that some preexisting gaps in mathematics and science preparation closed over time or even reversed themselves. For example, the math credit gaps between Asian and Whites and Hispanics narrowed between 1982 and 2004. Also, the gap in credits earned in mathematics between Whites and Blacks in 1982 (favoring Whites) showed no substantive difference in 2004, where Blacks earned, on average, 3.7 credits, and Whites earned 3.6 credits, although the Black-White gap in advanced math course levels did not close (Dalton, et al., 2007; NECS, 1997). Transcript studies in 1998 and 2000 detected no racial/ethnic differences in rates of completing advanced courses in English or foreign language study. However, in 2004, Asian/Pacific Islanders completed advanced English and foreign language study at higher rates than any other group. In all three years, black students were found less likely to complete advanced foreign language courses than the other ethnic groups (NCES, 2007).

Rigorous course-taking among racial–ethnic groups seem to mitigate inequity in short and long–term academic achievement, while differential course-taking patterns reinforce such inequity. For example, Lee, Croninger, & Smith (1997) found that in schools with few options other than rigorous academic course work, achievement differences among racial-ethnic groups and SES groups were smaller. Davenport et al. (1998) concluded that racial-ethnic discrepancies in high school course-taking transform into discrepancies in postsecondary achievement and participation in science and math fields.

The difference in course-taking patterns by SES groups is evident. Students from high-SES backgrounds completed advanced courses in mathematics and science at higher rates than did those from low-SES backgrounds. The highest SES group is substantially advantaged over other groups in completing pre-calculus and calculus; chemistry I and physics I; and chemistry II, physics II, or advanced biology. Based on the data from 1982 to 2004, students in each of the four SES quartiles increased their participation in advanced mathematics and science courses over time. The mean number of credits earned in science increased for students from all SES quartiles and the increases were comparable for all SES groups over time. The percentage of graduates in each SES quartile completing all levels of courses also grew over time. However, the percentages of graduates from quartiles below the fourth (highest) SES quartile completing calculus were much lower than those in the fourth

SES quartile. In addition, fourth SES quartile students also increasingly outpaced their closest peers in the third SES quartile by large extent. Students in the highest SES quartile made greater absolute gains in completing pre-calculus than did their peers in the first and second quartiles. But in chemistry I or physics I, the largest gains among SES quartiles were observed for the first (lowest) group compared to the other groups. The gap between the lowest two quartiles and the highest quartile persisted in completing science courses at the two most advanced levels, that is, chemistry I and physics I, and chemistry II, physics II, or advanced biology (Dalton, et al., 2007).

Finally, school sectors represent one aspect in which the difference in course-taking patterns occurs. Students attending schools in separate sectors may be systematically exposed to different curricular opportunities and peer influences related to selecting courses. Catholic school and other private school graduates were more likely than their public school peers to persist in the course-taking pipeline longer. They had higher rates of enrolling in and completing advanced courses in mathematics (pre-calculus and calculus) and science than their public school peers. Between 1982 and 2004, public high school students earned fewer maths and science credits than their Catholic or other private high school peers (Dalton et al., 2007). It is interesting that the significance of the school sector effect persisted even when the individuals' demographic and academic characteristics were taken into account. Some researchers attributed the school sector effect to the constrained curriculum design model that Catholic and private schools were following (Lee et al., 1998).

Since SES, ethnicity, school sectors and course-taking patterns are often confounded their relations would not be fully understood if they are studied in isolation. One has to take various variables into consideration when doing comprehensive research on gender, race, and SES differences in achievement growth.

Differences in SAT scores among subgroups

The College Board report (2006) reviewed the gender, racial/ethnic, language, and socioeconomic subgroup performance differences on the SAT, as well as the demographic composition of test-takers over the last two decades. The trend data indicated that subgroup differences had remained generally consistent over nearly the last two decades.

For many years since the SAT was first introduced, women tended to score higher on the verbal section and men scored higher on the mathematics section. However, starting in the early 1970s, women began to lose the advantage they once held on the SAT verbal section and made little progress in mathematics (Murphy, 1992).

Beginning in the 1960s, when the composition of students taking the SAT became more racially and ethnically diverse, mean score differences between racial/ethnic minority groups and white students became increasingly salient. The racial/ethnic groups that are typically the focus of concern are American Indian or Alaskan natives, African Americans, Asian Americans, and Hispanics. Camara and Schmidt (1999) reported that group differences appeared to be fairly consistent across admissions tests, including the SAT, ACT, GRE, GMAT, MCAT, LSAT, and other measures of educational attainment such as the National Assessment of Educational Progress (NAEP), National Educational Longitudinal Survey (NELS), and AP Program Examinations. The largest gaps are between white and African American students, followed by white and Hispanic students. Hedges and Nowell (1998) reviewed several large-scale studies of test score differences since 1965 among secondary school students and concluded that African American students scored between .82 and 1.18 standard deviations below white students in composite test scores. Camara and Schmidt (1999) also found that Asian American students' test performance was nearly identical to that of white students, with two exceptions: (1) Asian American students scored lower than white students on the SAT verbal section, and (2) Asian American students scored higher than white students on the GRE Quantitative test.

As a result of the increase in immigrant populations, the U.S. students are becoming more linguistically diverse than before, so it is necessary to examine subgroup differences in varying language groups (Pennock-Román, 2002). Students who were limited in English proficiency were more likely to obtain low verbal scores on standardized admissions tests (Pennock-Román, 1999). For a person whose first language was not English, a test other than a verbal test but administered in English became primarily a test of language proficiency rather than a test measuring the skills and abilities that were intended to be measured (Pennock-Román,1990). In a study of how language characteristics of Hispanic students might affect their entrance to college, Duran, Enright, & Rock (1985) found that overall SAT scores were lower for people whose first language was not English, even when they indicated that English was their best language. Thus, the standardized tests have rendered the students with English as the second language as disadvantaged.

As for the socioeconomic effect on SAT scores, standardized tests such as the SAT have been criticized as a better measure of parental income than of verbal or math ability, because test scores and family income are positively correlated (Zwick, 2004). However, studies have also shown that family income is related to many other measures of educational outcomes including HSGPA, the completion of certain courses, enrollment in college immediately after high school, greater expectations of attending a four-year college, completing an admission test and applying to a four-year college, and acceptance at a four-year college (Camara and Schmidt, 1999; Owings, McMillen, and Burkett, 1995).

Many frameworks have been presented to explain the subgroup differences on the standardized achievement tests. For example, Scheuneman and Slaughter (1991) presented the typical explanations in five broad categories: historical, cultural, biological, educational, and psychometric. Wiesen (2005) provided a comprehensive list of more than 95 possible reasons for the mean score differences between African Americans and whites found on cognitive ability tests, the primary categories of which included: physiological, economic and socioeconomic, psychological, societal, cultural, and test construction/validation explanations.

As has been mentioned in the previous section, it is quite difficult to disentangle the effects of these different explanations. Wiesen (2005) conjectured that no one reason was likely to account for more than a small fraction of the typical one standard deviation difference in mean test scores, but that it was possible that together, these explanations might account for much or all of that difference.

Research Questions

Based on the purposes set earlier, we are intended to answer the following questions through statistical analyses:

(1) To what extent are the SAT scores correlated with the state assessment scores?

(2) To what extent does the self-reported course-taking information from the SAT Questionnaire match that from the transcript?

(3) What is the relation between course-taking and the SAT score? Is the relationship invariant across subgroups?

(4) What is the effect size of course-taking on SAT scores when gender, ethnicity and SES are controlled?

Method

Data Resource

Data were collected from 2008 summer high school graduation classes in three districts in a middle-Atlantic state. Due to some legal issues on the agreement, access to the data is still pending.

Variables

In correspondence to our research goals, we used three sets of variables, including the achievement test scores, course-taking information, and variables with respect to background information.

Achievement test scores. SAT scores of the targeted students were collected. To obtain the evidence for validity of SAT, scores on state assessments of these students were identified and drawn from the state database.

Course-taking information. Course-taking information was collected from the SAT Questionnaire which is a self-report survey component. The questionnaire asked students to give the total number of years of high school courses taken or plan to take in six categories of subjects, including mathematics, English and language arts, natural sciences, social sciences and history, foreign and classical languages, arts and music. The choices ranged from 0, 1/2, 1, 2, 3, 4 to more than 4 years. Students were asked to indicate if it is a course at an advanced level including honor and advanced placement. To verify the accuracy of the self-reported curriculum information, a list of courses taken was also obtained from the transcript of each student.

Background variables. A number of background variables were also collected from SAT Questionnaire. Included are gender, ethnicity, primary language and SES.

Analysis

In the preliminary analysis, we are going to find out the evidence for the validity of the achievement in SAT by checking the correlations between SAT scores and state assessment scores. The accuracy of course-taking information extracted from the SAT Questionnaire will be verified by matching with the information derived from students' actual transcripts. Then, t-tests are to be conducted to compare the test scores between the students taking basic courses and those taking advanced level courses in each subject. Such t-tests will be conducted again in each subgroup (i.e. gender, ethnicity, high vs. low SES, high vs. low HSGPA) to check the difference between subgroups. Expectancy tables will be created to explore the effects of the number of years of course-taking on the SAT scores in each academic subject. Such expectancy tables are also created in each subgroup so as to check the invariance of the relation between years of course-taking and the SAT scores across subgroups. We will further conduct a multiple regression with categorical variables to detect the effect size of the number of years of course-taking on SAT scores when the background information variables (i.e., gender, ethnicity and SES) are controlled.

Implications and Limitations

SAT has long been characterized as "readily identifiable (if imperfect) national measures of college readiness." If we are able to provide expected SAT scores as a function of patterns of course-taking behavior through this study, we can regard the curriculum rigor as a predictor of college admissions/success. As a result, people will consider if students have taken the "right" courses that is in line with the college courses, and have obtained the "appropriate" skills that will benefit their postsecondary experiences. Students will also try to focus on the course material study rather than test-taking skills through expensive extracurricular test preparatory courses in order to succeed in admission tests and college curriculum. If the rigorous curriculum is justified to be associated with higher SAT scores and higher probability of going to college irrespective of gender, ethnicity and SES, it is worthwhile to develop more rigorous curriculum and provide equal opportunities to all students.

One possible limitation in this study is that the measures we used for course-taking pattern allow comparison between schools or classes, but it is difficult to comprehensively capture the differences in the content students are taught or the academic challenges for individual students. Another limitation is that our course numbers changed significantly in 2005, and it might be difficult to reconstruct from the transcript the courses taken by students prior to that year.

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