Transcript Analysis

This study examined an automated database containing complete transcripts of Suburban High School students beginning with class who graduated in June, 1996 as well as partial transcripts from earlier cohorts of students. The transcripts were used for two purposes.

First, the study analyzed the total number of hours during which students were enrolled in mathematics classes and in advanced mathematics classes from the beginning of Grade 9 through the end of Grade 12. Students who used a traditional curriculum and a traditional schedule for all four years of high school were compared to students who had used the IMP curriculum and a semestered block schedule throughout all four years of high school.

Second, the study investigated the number of students by grade level who were enrolled in Advanced Placement courses each school year from 1994-95 through 2000-01. This analysis was supplemented with data from annual School Profiles published by Suburban High School, which reported student grades on Advanced Placement tests administered by the college board.

Results from Analysis of Complete High School Transcripts

The specific groups of students compared in the analysis of complete high school transcripts were different from the groups used to analyze algebra achievement at the end of Grade 11. Of the students in the two Reform cohorts, only students in the First Reform cohort had completed twelfth grade at the time this part of the research was conducted, so only their transcripts were used. Also, students in the Traditional cohort who were tested at the end of eleventh grade in May 1997 went on to use a semestered block schedule during the 1997-98 school year. For this reason, their transcripts were not used for the analysis of transcripts through the end of Grade twelve. Instead, this part of the study analyzed transcripts of students from the two previous "Traditional" cohorts: those students who graduated in the spring of 1997, and those who graduated in the spring of 1996. Students who graduated in those years used a traditional curriculum and schedule throughout high school.

Students who attended Suburban High School from the beginning of Grade 9 through the end of Grade 12 and graduated in the spring of 2001 comprise the Reform

group ($n = 234$) for this part of the analysis. Students who attended Suburban High School from the beginning of Grade 9 through the end of Grade 12 and graduated in the spring of 1996 or the spring of 1997 comprise the Traditional group ($n = 416$) for this part of the analysis.

For students in the Traditional group, each mathematics class lasted 43 minutes per day and met daily for the entire 180-day school year. Thus, each course accounted for 43 x 180/60 = 129 enrolled hours.

For students in the Reform group, each mathematics class taken during ninth grade lasted 80 minutes per day and met daily for an 80 day semester. Thus, each ninth-grade course accounted for 80 x 80/60 = 106.67 enrolled hours. For these students, each mathematics class taken during tenth through twelfth grade lasted 80 minutes per day and met daily for a 90 day semester. Thus course in Grades ten through twelve accounted for 90 x 80/60 = 120 enrolled hours.

Comparison of total hours enrolled in mathematics class. Table 1 compares the number of hours each group, Traditional and Reform, enrolled in mathematics class during Grades 9-12. As the Table shows, students in the Reform Group enrolled in more hours of mathematics than did students in the Traditional Group.

Table 1. Average Number of Hours Each Student Was Enrolled in Mathematics Class, Traditional vs. Reform Groups

	n	Total Hours Enrolled In Mathematics, Grades 9-12 (Mean per Student)	Average Yearly Enrolled Hours (Mean per Student)
Reform Group	234	564.7	141.2
Traditional Group	416	498.0	124.5

It should be noted when students who comprised the Reform Group in Table 1 were in ninth grade, Suburban High School used the pilot form of the semestered block schedule, under which each course lasted only 106.67 hours. Subsequent cohorts have used the modified block schedule throughout Grades 9-12, under which each course lasts 120 hours. Thus, it is likely that later Reform cohorts will report an even larger number of hours enrolled in mathematics class under the semestered block schedule than is reflected in the table.

The summary statistics in Table 1 obscure some important details about the number of hours students in the Traditional and Reform groups enrolled in mathematics class. Table 2 displays more details about the total hours students in each group were enrolled in mathematics from the beginning of Grade 9 through the end of Grade 12. The Table reports the percent of students within each group who enrolled in a particular number of hours of mathematics. Mathematics courses from which students withdrew before receiving a final grade, or for which students received a final grade of "F", did not count towards their total hours. The information in Table 2 is displayed graphically in Figure 1.

Table 2. Total Hours Enrolled in High School Mathematics for Traditional vs. Reform
Groups

Hours		Traditional	Reform
129	# students	3 students	
	% within Group	0.7%	
258	# students	5 students	
	% within Group	1.2%	
342.34	# students		1 student
	% within Group		0.4%
346.67	# students		3 students
	% within Group		1.3%

360	# students		1 student
	% within Group		0.4%
387	# students	43 students	
	% within Group	10.3%	
453.34	# students		2 students
	% within Group		0.9%
466.67	# students		81 students
	% within Group		34.6%
480	# students		2 students
	% within Group		0.9%
516	# students	361 students	
	% within Group	86.8%	
573.34	# students		33 students
	% within Group		14.1%
586.67	# students		63 students
	% within Group		26.9%
645	# students	4 students	
	% within Group	1.0%	
693.34	# students		18 students
	% within Group		7.7%
706.67	# students		21 students
	% within Group		9.0%
813.34	# students		2 students
	% within Group		0.9%
826.67	# students		6 students
	% within Group		2.6%
946.67	# students		1 student
	% within Group		0.4%

Figure 1. Total Hours Enrolled in Mathematics Class
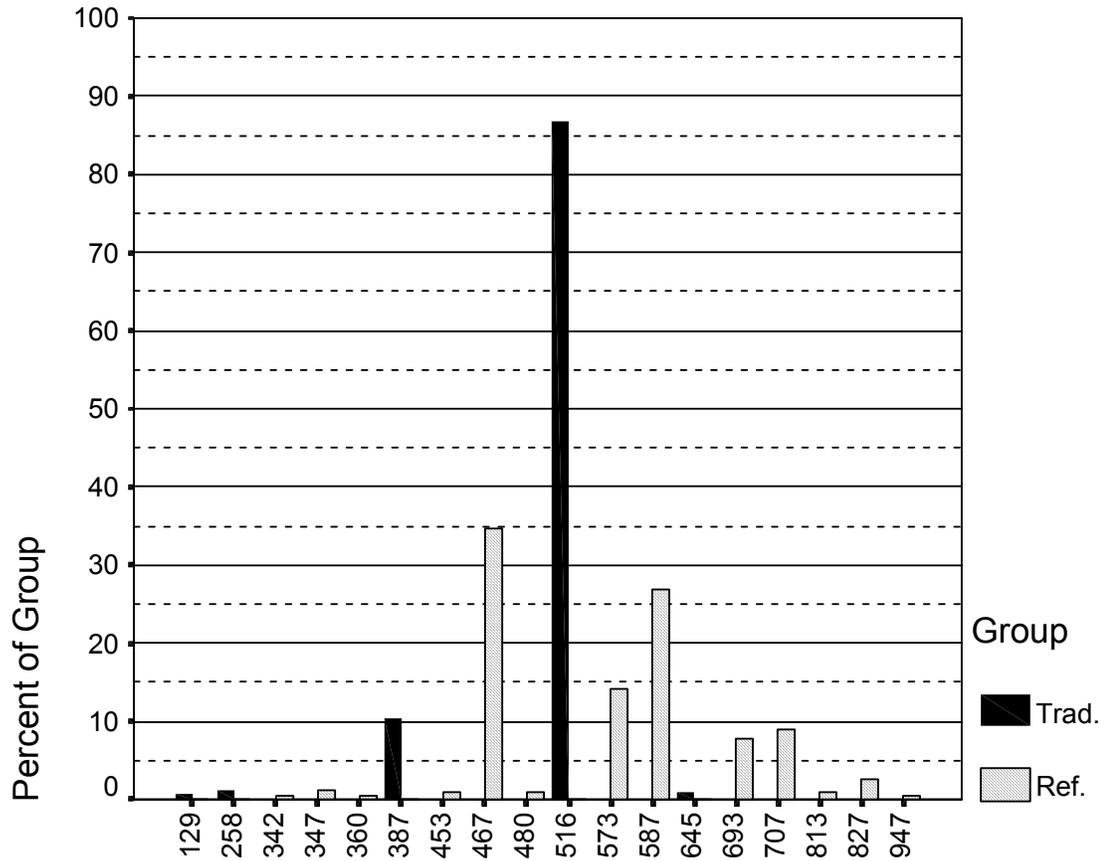
Several interesting trends are apparent in Figure 1. A large majority of students in the Traditional group enrolled in 516 hours of mathematics during high school. This is equivalent to four 129-hour courses or one mathematics course each year of high school. This was one course more than the Suburban High School graduation requirement under the Traditional schedule, which set a 3-course minimum for mathematics.

Some students in the Reform group enrolled in fewer hours of mathematics than the modal 516 hours for the Traditional group. However, Figure 1 shows that the

majority of students in the Reform group enrolled in more than 516 hours, and some substantially more. More than 20% of students in the Reform group enrolled in at least 693 hours of mathematics. In contrast, the largest number of enrolled hours for any student in the Traditional group is 645, equivalent to five traditional courses. Further, only 1% of students in the Traditional group enrolled in that much mathematics.

Under the semestered block schedule, Suburban High School required students to complete at least four mathematics courses in order to graduate. In Figure 1, students who enrolled in precisely this minimum of four courses are represented by the bars at 453, 467, or 480 hours of mathematics—the particular bar depending on what particular years they studied mathematics courses. Figure 1 shows that most students in the Reform group enrolled in more than the minimum number of mathematics courses required for graduation, as did students in the Traditional group.

Overall, 88% of students in the Traditional group enrolled in more than the minimum required number of courses, taking four or more mathematics courses during high school. Meanwhile, 62% of students in the Reform group enrolled in more than the minimum required number of courses, taking five or more mathematics courses during high school.

One way of looking at the information in Table 2 and Figure 1 is to ask what percent of students in the Reform group enrolled in more hours of mathematics than they likely would have under a Traditional schedule and curriculum. Of all students in the Reform cohort, 38% enrolled in fewer than 516 hours, the equivalent of taking four courses under the Traditional schedule. Of all students in the Traditional group, 12% enrolled in fewer than 516 hours. Thus a rough estimate is that about one quarter (38%

minus 12%) of students in the Reform group who were likely to have enrolled in 516

hours of mathematics under the Traditional schedule instead enrolled in fewer than 516

hours. The remaining three quarters of students in the Reform cohort enrolled in more

hours than they would have done under the Traditional schedule.   Some students in this

three quarters (12% of all Reform group students) are those who would probably have

enrolled in three or fewer mathematics courses under the Traditional schedule, and

instead enrolled in four mathematics courses under the semestered block schedule. The

rest of the students comprising this three quarters (62% of all Reform group students) are

those who enrolled in five or more mathematics courses under the semestered block

schedule.

   Comparison of hours enrolled in advanced mathematics classes. After

completing Algebra 2, students in the Traditional group could enroll in any one of the
following more advanced classes: Algebraic Analysis, Algebraic Analysis Honors, Pre-
Calculus/Discrete Honors, Calculus AB AP, or Calculus BC AP.
   The Algebraic Analysis courses used the text *Functions, Statistics, and*

Trigonometry with Computers (Rubenstein, et al., 1992).   This is the fifth of six

mathematics texts in a Grade 7-12 series designed by the University of Chicago School

Mathematics Project (UCSMP). In sequence, it was designed to be used immediately

after students had completed the Algebra, Geometry, and Advanced Algebra courses.

The authors recommend that all college-intending students study material covered in the

text to prepare them for the wide range of mathematics found in virtually all college

majors today. The Pre-Calculus/Discrete Honors course utilized the final book in the

UCSMP series, *Precalculus and Discrete Mathematics* (Perissini, et al., 1992). The text

contains material intended to prepare students for Calculus and other college courses

usually taken by mathematical and physical science majors. The two calculus courses

used the text *Elements of Calculus and Analytic Geometry* (Thomas & Finney, 1989).

One course offered to students in the Traditional group, Algebra 3/Trigonometry, was intended for students who had difficulty with Algebra 2, or students who completed the less advanced course Algebra 2 Career/College Prep instead of the regular Algebra 2 course. It covered Algebra 2 from a different perspective, using the text *Advanced Algebra* (Senk & Thompson, 1993). *Advanced Algebra* is the fourth book in the UCSMP series, and is recommended for all high school students, whether or not they are college-intending. Because of its content, this study did not count "Algebra 3/Trigonometry" as an "advanced class," despite the course title.

After completing Integrated Math 4, students in the Reform group could enroll in any of the advanced courses that had been offered to the Traditional group except for the Honors version of Algebraic Analysis, which was dropped from the curriculum. Although most of the courses were renamed at about the time Suburban High School adopted the semestered block schedule, most continued to use the same texts and to present basically the same material. The two most significant changes made were to Pre-Calculus/Discrete Honors and to Calculus. Pre-Calculus/Discrete Honors was renamed Functional Analysis Honors and dropped a number of topics in discrete mathematics that were taught in a new Discrete Analysis course. The two calculus courses utilized a more recent book than did students in the Traditional cohort: *Calculus: Graphical, numerical, and Algebraic* (Finney, Demana, Waits, & Kennedy, 1999). The first author of the text, Ross Finney, had been second author of the Calculus text utilized by the Traditional cohort.

Under the semestered block schedule, four new advanced mathematics courses

were added to the Suburban High School curriculum. The new courses were: Discrete Analysis, Discrete Analysis Honors, Statistics, and Statistics AP. Both Discrete Analysis and Discrete Analysis Honors utilized the text *For All Practical Purposes* (Garfunkel, 1997) to study topics like networks, task scheduling, and weighted voting systems. Although Statistics and Statistics AP covered similar topics and used the same supplementary materials, the primary texts were different. "Statistics" utilized the text *Elementary Statistics* (Bluman, 1992), which emphasizes a non-theoretical approach, explaining concepts intuitively, supporting them by examples, and avoiding formal proofs. In contrast, "Statistics AP" utilized the text *The Basic Practice of Statistics* (Moore, 1999) which was written to be used in an introductory level college statistics course.

While Suburban High School introduced four new mathematics courses simultaneous with adoption of a semestered block schedule, it cannot be certain that the schedule alone accounted for this decision. In particular, the College Board first administered an Advanced Placement statistics examination in May of 1997. The decision to introduce an AP Statistics course at Suburban High School during the 1997-98 school year may have been as much a reaction to the newly available examination and related materials, as it was a reaction to the increased number of courses available to Suburban High School students under the block schedule.

Table 3 compares the mean number of hours students in each group, Traditional and Reform, enrolled in advanced mathematics courses during Grades 9-12. As the table shows, on average students in the Reform Group enrolled in more hours of advanced

Table 3. Difference Between Groups on Mean Hours Enrolled in Advanced Mathematics Classes

Treatment		All Students			Students With At Least One Advanced Course		
	n	Mean Hours	Standard Deviation		Mean Deviation	n	Standard Hours
Reform	234	132.8	143.3		135	230.2	114.5
Traditional	416	96.8	65.4		110.8	199	202.3

mathematics than did students in the Traditional Group. This is true among all students in the data set, and even among the set comprised of only those students who took at least one advanced mathematics course.

The summary statistics in Table 3 obscure some important details about how many hours students in the Traditional and Reform groups enrolled in advanced mathematics courses. Table 4 displays more details about the total hours students in each group were enrolled in advanced mathematics courses from the beginning of Grade 9 through the end of Grade 12. The table reports the percent of students within each group who enrolled in a particular number of hours of advanced courses. Advanced mathematics courses from which students withdrew before receiving a final grade, or for which students received a final grade of "F", did not count towards their total hours.

Table 4. Total Hours Enrolled in Advanced Mathematics Courses for Traditional vs.

Reform Groups

Hours		Traditional	Reform
0	# students	217 students	99 students
	% within Group	52.2%	42.3%
120	# students		52 students
	% within Group		22.2%
129	# students	87 students	
	% within Group	20.9%	
240	# students		55 students
	% within Group		23.5%
258	# students	111 students	
	% within Group	26.7%	
360	# students		17 students
	% within Group		7.3%
387	# students	1 student	
	% within Group	0.2%	
480	# students		9 students
	% within Group		3.8%
600	# students		2 students
	% within Group		0.9%

The information in Table 4 is displayed graphically in Figure 2. As can be seen in

Figure 2, students in the Reform group were more likely than students in the Traditional

group to take at least one advanced mathematics course. In the Reform group, 57.7% of

all students took at least one advanced course, compared to 47.8% of students in the

Traditional group. A Pearson Chi-square statistic was computed to test the statistical

significance of the difference between cohorts in the odds of a student enrolling in at least

one advanced mathematics course. The test yielded a Chi-square statistic of 5.82,

$p<.016$. The Chi-square test was conducted after visual inspection of the graph to look

for important patterns, so the low p-value could be spurious.   Nonetheless, the

significance level is an indication that the difference cannot easily be dismissed as

chance.

Figure 2. Total hours enrolled in advanced mathematics courses.
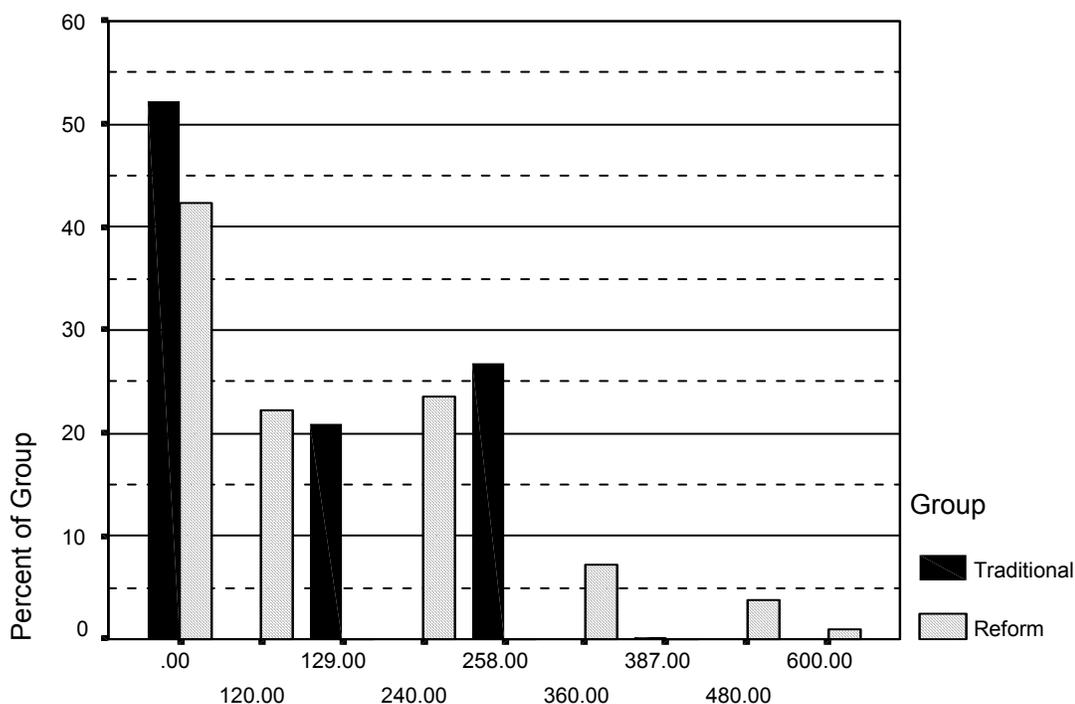
For students who enrolled in one or two mathematics courses, the amount of course time scheduled was greater in the Traditional group than in the Reform group: an advantage of nine hours course-time per course. However, this deficit was balanced out by the much greater likelihood that students in the Reform cohort would take three or more advanced courses.

Overall, Figure 2 along with Table 3 and Table 4 show that students in the Reform group were more likely than students in the Traditional group to enroll in at least one advanced mathematics course. Further, 12% of students in the Reform group enrolled in three or more advanced mathematics courses, as opposed to less than 1% of students in the Traditional group who did so. Although each mathematics course

comprised fewer hours for the Reform group, the tendency of students in the Reform group to enroll in a larger number of courses more than balanced this out. Thus, on average students in the Reform group spent more hours in advanced classes than did students in the Traditional group.

In computing the number of hours students were enrolled in advanced courses, Table 3, Table 4, and Figure 2 did not count Integrated Math 4 Honors as advanced. There were several reasons for this decision. At Suburban High School all versions of Integrated Math 4 tended to be viewed as part of the core mathematics requirements. For example, before students could enroll in Discrete Analysis, Algebraic Analysis, or Statistics they were expected to complete either Integrated Math 4 or Integrated Math 4 Honors. Also, students generally completed the Honors sequence relatively early in their high school careers. Only 2 of the 84 students in the First Reform cohort who took the course did so during the 2000-2001 school year, which was the first year the Integrated Math Honors course syllabus called for all the modules in the IMP textbooks to be completed. Previously, teachers had still been familiarizing themselves with the curriculum, and therefore the Honors courses did not complete the modules *Is There Really a Difference, Pennant Fever*, or *The Pollster's Dilemma*. Thus, for students in the First Reform Cohort whose transcripts were analyzed in this study, Integrated Math 4 Honors probably should not count as an "advanced" course.

Nonetheless, in looking at the long term effects of the IMP curriculum and semestered block schedule, the reader should note that for subsequent cohorts Integrated Math 4 Honors probably would count as an "advanced" course. Beginning in 2000-2001, Integrated Math 4 Honors syllabus contained all modules in the entire IMP Year 4 textbook. According to teachers at Suburban High School, in 2000-2001 they did not finish the entire syllabus, leaving out the module *Is There Really a Difference?* but they anticipate completing the entire Book 4 during 2001-2002. Webb (in press) counted a course designed from a preliminary version of the IMP Year 4 text as "advanced."

Although some of the topics contained in IMP Year 4 would likely be found in a traditional Algebra 2 course, the bulk of the topics are more likely to be seen in subsequent courses. Further, students who completed the entire Integrated Math Honors sequence would have completed two modules containing advanced topics in matrix algebra and probability and statistics when they took Integrated Math 3 Honors. A graphical analysis not shown here indicated that the primary effect of counting Integrated Math 4 Honors as an "advanced course" would be a substantial increase in the reported percent of students who enrolled in 360 hours or more of advanced mathematics.