HIGH SCHOOLS THAT WORK AND WHOLE SCHOOL REFORM: RAISING ACADEMIC ACHIEVEMENT OF VOCATIONAL COMPLETERS THROUGH THE REFORM OF SCHOOL PRACTICE

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TABLE OF CONTENTS

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EXECUTIVE SUMMARY

School-wide efforts to improve the education of American students have been implemented in many schools throughout the nation. The Southern Regional Education Board's *High Schools That Work (HSTW)* network stands out as one of the few consortia to coordinate that effort and to collect and analyze data as part of a service to its participants. On a biannual basis, the participating schools assess their graduating vocational completers in science, mathematics, and reading using the *HSTW* Assessment. They also collect data on student course-taking patterns, student behaviors and attitudes, and teacher attitudes and characteristics. In addition to creating useful comparison data for benchmarking the progress of individual sites, the assessments enable SREB to test theories about basic associations between certain practices or attitudes and student outcome measures.

Several underlying questions, however, remained unanswered, such as, "Can we look into the black box of whole school reform and provide evidence of particularly effective practices?" Using the test scores from 1996 and 1998, demographic variables to control for changes in the tested student body, and variables that correspond to the key practices of *High Schools That Work*, this analytic study attempts to provide insight regarding individual practices or program elements. In order to reach findings that might prove useful to schools attempting to raise student achievement, all data were aggregated to the school level.

For the 424 schools in this study, the mean gain in the three assessment subjects between 1996 and 1998 ranged from 4 to 13 points. We looked specifically at six clusters to represent the key practices promoted by *HSTW*: (1) curriculum standards, (2) instructional goals, (3) academic/vocational integration, (4) guidance counseling, (5) teacher practices, and (6) work-based learning. Some of the clusters were more easily captured by data elements than were others. In addition, it appears that some clusters were more operational within schools than were others. In other words, schools had room for improvement and made positive changes between 1996 and 1998 for some clusters, while for others, the opportunity for improvement on these measures was slight or not taken advantage of.

This analysis predominantly explores the individual impact of each cluster on student achievement, while controlling for changes in student demographics. Overall, increases in the proportion of students meeting *HSTW* curriculum standards had a large impact on achievement gains in science, reading, and math. Changes in the proportion of students perceiving that their academic and vocational teachers were working together to improve students' mathematics, reading, and writing skills had almost as much positive effect in the statistical model as curriculum changes. Likewise, increases in the amount of time that students spent talking to their guidance counselors and teachers about their school program were directly associated with increases in the schools' mean assessment scores. The other clusters seemed to have little or no explanatory power for predicting school changes in student academic achievement.

In any analysis of such places as schools, cause and effect are difficult to determine, and corresponding data are difficult to collect. Our primary purpose in this study was to examine the correlates of success in the *HSTW* network using the *HSTW* Assessment and survey data. However, we also hope that this analysis—using fairly simple models with school-level data—might spark others to consider similar data presently used for report cards as a source for thoughtful research and study.

INTRODUCTION

School-wide reform efforts have been in favor for several years among educational policymakers. Whether it is called "whole school reform," "comprehensive reform," or "school-wide reform," much of the educational research community has endorsed this approach to improving school achievement. Reflecting the growing acceptance of this approach among educators, Congress in 1994 passed the *Comprehensive School Reform Demonstration Program* ("Obey-Porter"). This bill specifically endorsed 24 reform strategies that were classified as "whole school" reform approaches. While there is wide agreement on the theoretical benefits of whole school reform, there have been few empirical studies of the outcomes of these reform efforts. For example, in a review of the research literature on the 24 programs cited in *Comprehensive School Reform Demonstration Program* the American Institutes for Research (AIR) found few studies of student outcomes that had what they considered "rigorous" research designs (American Institutes for Research, 1999). This study attempts to fill some of this void by looking at the student outcomes of one of the programs included in the Obey-Porter Bill—the *High Schools That Work* (*HSTW*) initiative.

HSTW began in 1988 as a pilot project of the Southern Regional Education Board's (SREB) Vocational Education Consortium with a group of 28 schools across the southeastern United States. In the past 10 years, more than 900 school sites have joined the *HSTW* consortium, and evidence suggests that many of these schools have increased student achievement.

Since the beginning of the effort, SREB has used assessment scores, transcript data, and survey information to keep track of the progress being made by the schools in the consortium. After the Educational Testing Service (ETS) analyzed the results of the 1996 *HSTW* Assessment, SREB announced that student test scores had increased from 1993 to 1996 in all three tested subject areas and increased from 1994 to 1996 in reading and math. The average reading score increased from 267 (in 1993) and from 264 (in 1994) to 272; mathematics scores from 285 (in 1993) and 281 (in 1994) to 286; and science scores from 270 (in 1993) and 282 (in 1994) to 283.[1]

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[1]From 1993 to 1996, the average reading score increased by 0.19 standard deviations (SD=25.65); the average mathematics score increased by 0.03 standard deviations (SD=29.32); and the average science score increased by 0.36 stan-

HSTW is based on the belief that all students—including students traditionally in the vocational or general track—can master rigorous academic curriculum if they are exposed to the right school environment. The "right" environment for *HSTW* is a school that "blends the essential content of traditional college-preparatory studies—mathematics, science and language arts—with quality vocational and technical studies" (Bottoms and Mikos, 1995). Therefore, while calling for whole school reform, the *HSTW* initiative is particularly interested in the outcomes of students commonly placed in vocational or general studies.

The focus of this study is the academic outcomes for students who completed a concentrated sequence of vocational coursework—a group referred to as vocational completers. Data that had already been collected by schools within the *HSTW* network for internal purposes is used in this study. In the past, these data have been used by schools to measure various aspects of the implementation of the *HSTW* program. They were not specifically collected to evaluate the effectiveness of the *HSTW* initiative. The use of these data produced enormous cost savings over collecting our own data for an evaluation of *HSTW*.

Furthermore, in many ways the data collected by these schools are similar to the data now being collected by various states and localities for "school report cards." Therefore, this research project was an opportunity to test the feasibility of using school-based data collections to provide quantitative information on school effectiveness. In the present study, using student and teacher survey, transcript, and ETS test score data, a statistical model has been developed to determine which practices were most closely associated with high student performance, as measured by student test scores in reading, mathematics, and science.

dard deviations (SD=33.45). From 1994 to 1996, the average reading score increased by 0.19 standard deviations (SD=29.97); the average mathematics score increased by 0.17 standard deviations (SD=29.44); and the average science score increased by 0.03 standard deviations (SD=29.6).

METHODS

Data Sources

This study used a variety of data from multiple sources, including teacher and student surveys, high school transcripts, and achievement test scores in science, mathematics, and reading. This section describes each data source, how the information was collected, and how the data were used in this analysis.

HSTW Assessment Scores

On a roughly biannual basis,[2] staff at each *HSTW* site administer the *HSTW* Assessment—a series of tests based on the science, mathematics, and reading examinations included in the National Assessment of Educational Progress (NAEP)—to a selected group of students. These students are seniors and are expected to graduate with four Carnegie units of credit in a vocational concentration.[3] In this study, this group of students is referred to as vocational completers.

Of the approximately 650 sites that were part of the *HSTW* network during 1998, 425 had data points for the two-year cycle. The test score data were used as dependent variables in the statistical analyses, measuring increases and decreases in student performance in science, mathematics, and reading from 1996 to 1998.

Surveys

In addition to the science, mathematics, and reading assessments, vocational students also responded to a battery of survey items as part of the *HSTW* Assessment. Vocational students reported what they were taught, how they were taught, what was expected of them, and what effort the school put forth. This data set also includes enough transcript information to determine the percentage of students who completed SREB's recommended curriculum in science, mathematics, English, and vocational studies at each site in 1996. During the same semester that students are tested and surveyed, educational staff

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[2]Tests have been administered in 1988, 1990, 1993, 1994, 1996, and 1998. In order to manage the growth of the initiative from 38 sites in 1990 to an expected 500 sites in 1994, testing was suspended in 1992; sites were added in two phases in the years 1993 and 1994.

[3]Most states do not define "vocational completer" and use *HSTW*'s definition of four Carnegie units in a vocational concentration to select students who will be assessed. However, a few states or districts do have their own definitions, and in a few instances, they vary from the *HSTW* definition.

also complete a written survey.[4] Site staff responded to items concerning the integration of academic and vocational education, amount of time devoted to teaching basic academic skills, and staff development needed to achieve quality learning for more students. These student and teacher data, along with the student test scores, provided the basis for the quantitative analysis.

Statistical Analysis Procedures

In theory (and with an unlimited budget), assessing the effectiveness of a school reform effort should be straightforward. By either experimental design or quasi-experimental design, groups of schools are randomly assigned to control and experimental groups. If a group of schools that have implemented the reform package at t_1 has overall gains in achievement by t_2 and the control group of schools does not, then one can come to the tentative conclusion that the reform had the desired effect. In practice, many things can go wrong with an evaluation based on the best of research designs—not the least of which is actually implementing the design in the first place. To paraphrase Donald Campbell, experiments can turn into quasi-experiments, which too often then turn into "queasy-experiments."

However, in this study we do not have the luxury of even starting with an experimental or quasi-experimental design. As mentioned previously, for reasons of cost and practicality, a design that capitalized on the ongoing data collection efforts of SREB was used. Both the assessment data and the individual survey data had already been collected for *HSTW*. Furthermore, these data were originally designed to enable schools within *HSTW* to track the school's own progress compared with the *HSTW* network and national comparisons; the data were not designed explicitly for overall evaluative purposes. In addition, all the schools in the *HSTW* sample are theoretically receiving the same treatment. That is, the same set of key practices are being implemented in each school—although as we shall see, with varying degrees of success. To further complicate matters, the assessment data are not longitudinal in that they do not track individual students over time, but are sets of multiple cross-sectional data. Each survey year represents a new cohort of vocational completers. We are thus left with a one-group pretest/posttest design where the

[4] Site coordinators are instructed to survey at least the English, mathematics, science, and vocational/technical teachers. They are encouraged, but not required, to give the survey to teachers of other subject areas.

pretest and the posttest are conducted on different sets of students and the treatment has already been introduced, albeit at different levels of "dosage."

Even given the inherent deficiencies in the data we felt that an analysis of these data would be worthwhile. A great deal of data has been collected from students, teachers, and other school staff over several years that can be used to give understanding as to what works in the cluster of practices within *HSTW*. Furthermore, many states are producing school "report cards" that are based on data much like the data collected by the *HSTW* network. If examining the *HSTW* data leads to insights into aspects of program effectiveness, practitioners may be able to use this same approach with their own data to give them similar insights into their own reform efforts.

Study Design

In many instances, researchers are merely interested in whether or not the program was effective. The explanatory variable then can become a single measurement of program implementation, or a set of variables that represent aspects of the program. The size and statistical significance of the added explanatory power of these variables (measured by the R^2 added due to these variables) then becomes evidence for school improvement due to program implementation. This is the classic "black box" evaluation.

In "whole school" reform, however, many things may be going on inside the black box. In the present case, practitioners at SREB are interested in peeking into the box to see what aspects of *HSTW* have been particularly effective (or ineffective). That is, what among the several key practices led to observed gains in school-wide achievement? One might be tempted to do this by using standard multivariate analysis and assessing the *unique* contribution of each independent variable within the set of variables representing the program (the X_j) on predicting differences in the school outcome variable (Y). This unique contribution could be assessed by examining the regression coefficient of X_j on Y (b_j), the partial correlation of X_j with Y (pr_j), or the semi-partial correlation of X_j with Y (sr_j) (Darlington, 1990).

However, in the present case where there are lots of things changing within the school—some due to reform, some not—the *unique* contribution of a particular practice is not particularly interesting nor informative for policy. This is because schools, like most social institutions, are messy cause and effect soups. Many terms and analogies have been used to describe this messiness; such have been referred to as "loosely coupled systems" and as causal "garbage cans," but the effect described is the same (Weick, 1969). In whole school reform, lots of things are going on simultaneously. A simple analogy may be of use:

In classic Newtonian physics, one can predict with some accuracy the effect of hitting the cue ball on the eight ball when the cue ball is hit at a certain angle and with a certain force. In "whole school" reform efforts, there may be several "cue balls" that are hit—sometimes simultaneously, sometimes not. That is, various changes in practice or pedagogy may be happening within the school at the same time. This is the point of whole school reform. The elements of these practices are also dependent—improvement in one [practice one] will be associated with improvement in another [practice two], as though several cue balls are tied together with varying lengths of cord and are then shot at the eight ball.

In the present case, SREB has tried to implement numerous practices that are closely related to one another—for example, setting high expectations and replacing the general track with a solid academic core curriculum. Therefore, rather than look at the unique contribution of each independent variable, this analysis looks at the association of each independent variable with school improvement after introducing a limited set of control variables. We explore the association of each key practice with gains in achievement by examining the beta coefficient for each individual variable within the set of variables representing the key practice. This regression coefficient results when only that variable is entered into the equation with the control variables—that is, the regression coefficient for that variable in a model that contains the control variables and only that one variable.

We also present and discuss the amount of variance explained by the set of variables representing a key practice—the R^2 added. However, we would like to caution the reader in over-interpreting this statistic for each of these explanatory variables. We provide these statistics as a descriptive measure of the explanatory power of the variable, and they are not intended to be used as a measure of the size or "importance" of each variable. The betas are provided as a measure of importance.

Data Elements

Achievement gains. We aggregated to the school level the vocational student-level achievement data for 1996 and 1998. The level of analysis then became the school. We then used a measure of regressed change for our outcome variable. That is, we regressed the mean achievement in 1998 on achievement in 1996, creating a posttest score that was regression-adjusted. We did this for each subject area: mathematics, science, and reading. Thus, the outcome measures of "change" were uncorrelated with the pretest scores and avoided many of the problems with simple change scores.[5] The model used in this process is shown below:

$$\hat{Y} = B_0 + B_{test96} X_{test96} \qquad \text{(Equation 1)}$$

where $\hat{Y}$ = 1998 test score.

Control variables. One of the threats to the validity of this study was that within a school there might have been changes in the composition of test takers from 1996 to 1998. Differences in a school's mean test score might be due to large differences in the composition of vocational completers from one year to the next and not to changes in program practices. We therefore controlled for changes in the racial-ethnic composition and socioeconomic status of the test takers by including variables measuring racial-ethnic composition, mean level of students' fathers' education, and mean level of students' mothers' education for both 1996 and 1998. The model used is shown below:

$$\hat{Y} = B_0 + B_{test96} X_{test96} + B_1 X_1 + B_2 X_2 + B_3 X_3 + B_4 X_4 + B_5 X_5 + B_6 X_6 \qquad \text{(Equation 2)}$$

where:

X_1= Percentage of school's minority students in 1998;
X_2= Percentage of school's minority students in 1996;
X_3= School mean father's education level in 1998;
X_4= School mean father's education level in 1996;
X_5= School mean mother's education level in 1998; and
X_6= School mean mother's education level in 1996

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[5]For a discussion of regressed-adjusted change scores, see Burr and Nesselroade, 1990; and Cohen and Cohen, 1983.

Program variables. The *HSTW* initiative has a detailed list of key practices and objectives (see the Appendix). From reviewing these practices, we were able to establish six clusters of practices that grouped similar procedures and goals. These clusters were identified as (1) curriculum standards, (2) instructional goals, (3) academic/vocational integration, (4) guidance counseling, (5) teacher practices, and (6) work-based learning.

As previously mentioned, however, as, the survey instruments used by the schools were not designed to examine specific changes over time in the implementation of the list of key practices nor the sets of related goals identified. The key practices are broad and complex; successive surveys were constructed to tap into and measure varying aspects of the broad practices of current interest to *HSTW* administrators, with only a subset of items remaining constant from year to year. Aspects of the program that were of interest to *HSTW* administrators in one year may not have been of critical interest the next. Therefore, one of the challenges of this analysis was to identify common items from the 1996 and 1998 surveys that measured the same aspects or clusters of key practices. Variables that measure most of the clusters of key practices within *HSTW* were identified; however, as will become apparent in the results section below, some clusters of practices were more fully operational than others were.

The clusters of *HSTW* key practices that could be measured are described below. In the results section, the actual variables used to define these clusters are listed. The clusters of practices we examined were as follows:

1) Curriculum Standards

The centerpiece of *High Schools That Work* is raising the expectations of students by replacing the general track—a system that has traditionally allowed students to graduate from high school without completing a rigorous academic core—with a curriculum that blends the essential content of college preparatory science, mathematics, and language arts courses with challenging vocational/technical studies in grades 9 through 12. Among other requirements, the *HSTW*-recommended curriculum calls for at least three credits each in mathematics and science, with two credits in each subject from courses with content equal to that of college preparatory mathematics and science courses. The program of study should include science in the 11th or 12th grade and mathematics in the senior year.

2) *Instructional Goals*

Meeting course requirements is just a part of the goals of the *HSTW*. Changing the content and instructional delivery practices of teachers is also a major goal. There is great emphasis on meeting the needs of all students through a set of challenging academic and vocational courses that actively engage each student in the learning process.

3) *Academic/Vocational Integration*

One of the main features of the reform of vocational education in the United States has been the attempt to integrate the study of academic subject matter into the vocational curriculum. In this way, it is hoped that students not served by traditional academic instructional methods can learn basic academic skills in an applied curriculum setting. *HSTW* has long had this philosophy as a main component in its reform effort.

4) *Guidance Counseling*

Related to increased student expectations, but seen as a different set of practices, is the guidance and counseling of students. Whether conducted predominantly by guidance counselors or shared with the teaching staff, the function of career guidance and counseling—and encouragement to enroll in challenging courses—is a responsibility taken seriously in schools where improvement has occurred.

5) *Teacher Practice*

One goal of the *HSTW* initiative is to increase access to academic studies that teach the essential concepts from the college preparatory curriculum through functional and applied strategies that enable students to see the relationship between course content and their future.

6) *Work-Based Learning*

The *HSTW* initiative supports the philosophy that many students learn more effectively within a "real world" context—that is, within a "structured system of work-based and school-based learning" that involves schools working with employers within the local community to provide a career/employment context for the students' academic and vocational coursework.

Table 1 shows the measures of central tendency, variances, and the range for each set of variables that we used to represent the six clusters of practices. The first column of Table 1 shows the mean for each variable in 1996, while column 2 shows the within-school variance for each variable, and column 3 shows the between-school variances for each variable. The between-school variance for most of these variables was approximately 10 percent of total variance.[6] This indicates that the observed differences between the schools on these variables were not due to just random error.

Column 4 shows the mean difference between each variable in 1996 and the same variable in 1998. Table 1 also includes the variances and ranges for the change variable. We have also provided in Table 1 the measurement scale used for each variable or set of variables.

[6]For example, the between-school variance for the variable measuring the importance of the goal of social development was 0.039, accounting for 8.7 percent of total variance: 0.039/(0.039+0.417).

(Table 1 here)

(Table 1, continued, here)

RESULTS

Gains in Achievement

Table 2 displays the average gains between 1996 and 1998 in achievement in mathematics, reading, and science for the 424 schools in this study. The median gain ranged from 6 points in reading (about one-half of one standard deviation) to 12 points in mathematics (almost one full standard deviation). There was great variability in change though. Several schools had the measured achievement level of their vocational completers drop over the two years—some as much as 60 points. Some schools had impressive gains in achievement for their vocational completers—as much as 50 points in some instances. However, the reader should keep in mind that these mean scores are based on a set of vocational completers in each school and that each year represents a different cohort of vocational completers. As a result, some portion of the gains may be due to changes in the composition of vocational completers in a school from year to year. The mean number of vocational completers within schools was about 60 in 1998, with 15 as the minimum number and 261 as the maximum; however, equally impressive is the overall average gains by this set of schools. For example, the mean gain for all schools in mathematics was 13 points. Since the assessment is scaled to have a mean of 250 and a standard deviation of 50, this represents an average gain of about 1/4 of one standard deviation.

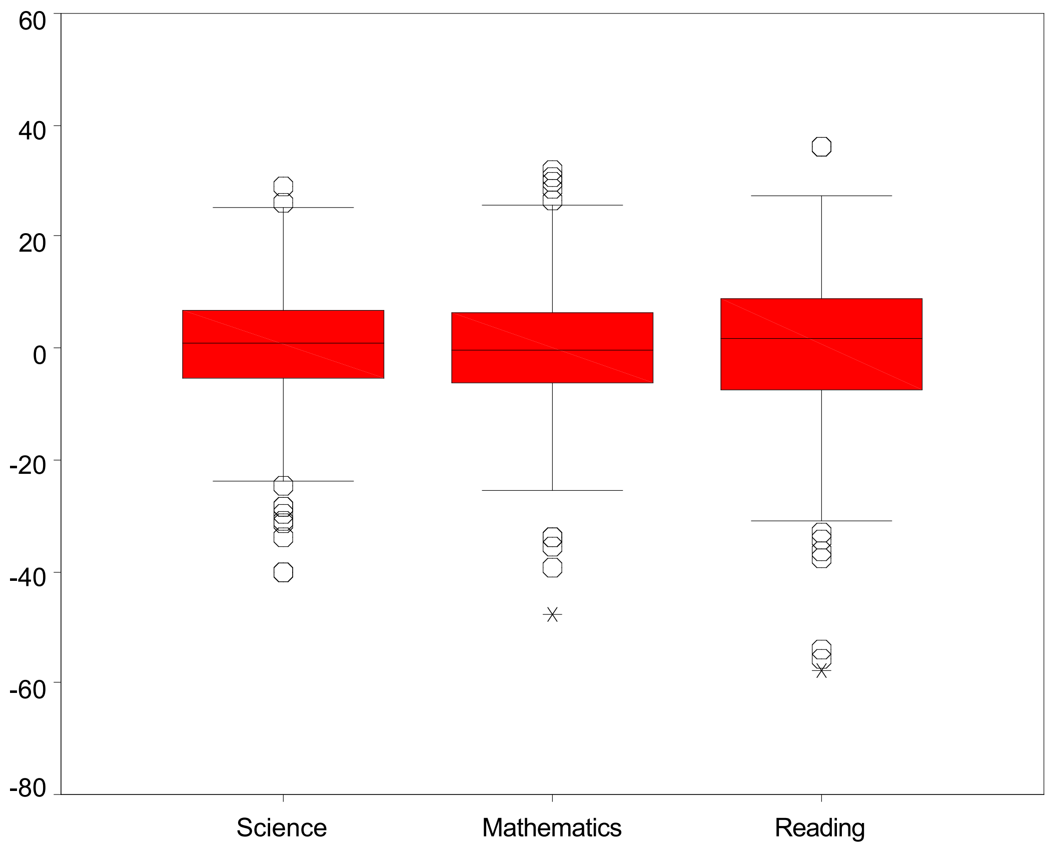
Table 2
Change in Science, Mathematics, and Reading Test Scores: 1996 to 1998

	N	*Mean*	*Median*	*Std. Deviation*	*Minimum*	*Maximum*
Science	424	9.4	9.5	11.2	-30.9	39.7
Mathematics	424	13.1	12.3	13.3	-39.4	54.8
Reading	424	4.4	5.6	14.8	-63.4	49.2

Figure 1 plots the residualized change scores for mathematics, science and reading for the schools in the study. These scores are the deviations of the predicted 1998 school means based on the 1996 school means derived from Equation 1 provided earlier.[7]

[7]For those unfamiliar with box plots, the boundaries of the box are the 25th and 75th percentiles, while the line in the middle of the box is the 50th percentile (the median). The symbols "O" in the plots represent "outliers" which are 1.5

Figure 1—Residualized change scores for science, mathematics, and reading achievement: 1998 scores regressed on 1996 scores



As with the simple change scores above, schools showed a great deal of variation in their gains in achievement of their vocational completers as measured by deviations in 1998 from their predicted scores based on their scores in 1996. Particularly striking were the schools that had large drops in achievement levels. Further investigation revealed that one school in particular (the one represented by the "*" in the plots above) had scored much lower on all three of the assessment areas—dropping from 40 to 60 points in each assessment. This school also did not have an unusually low number of vocational completers, testing 36 in one year and 46 in the other.

inter-quartile ranges (IRQs) from the end of the box. (The IRQ is the length of the box.) The symbol "*" represents extreme values and is more than three IRQs from the end of the box.

Control Variables

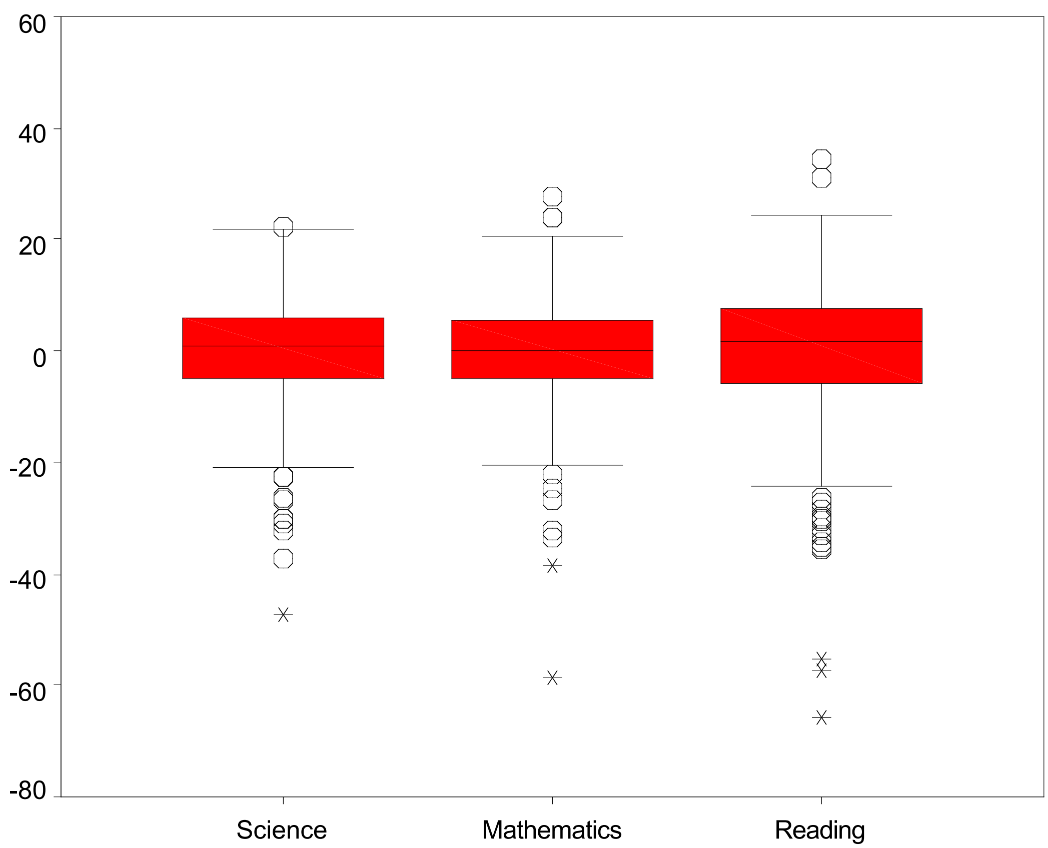
One explanation for this precipitous drop in achievement for some schools was that changes had occurred between 1996 and 1998 in the composition of the vocational completers in these schools. We therefore introduced a set of control variables into the model that attempted to measure changes in the social composition of the schools. This model is shown as Equation 2 mentioned previously. Table 3 shows the results from this analysis. Indeed, changes in the racial-ethnic composition and socioeconomic class of the schools' vocational completers seemed to be particularly useful predictors—explaining from 11 to 15 percent of the variance in 1998 residualized test scores. Figure 2 plots the residualized change scores for science, mathematics, and reading with the demographic central variables added to the model.

When these residuals were analyzed, the one outlier school stood out even more. After examining this school's data more carefully, we decided that while certainly an outlier in the statistical sense, other data from this school suggested that the drop in achievement levels was not just an error of some sort, but real. Furthermore, after running a few equations with and without this one case in the sample, we found few, if any substantive differences in the results and decided to include it in the rest of the analysis.

(Table 3 here)

Figure 2

Residualized Change Scores for Science, Mathematics, and Reading Achievement: 1998 Scores Regressed on 1996 Scores and Demographic Variables



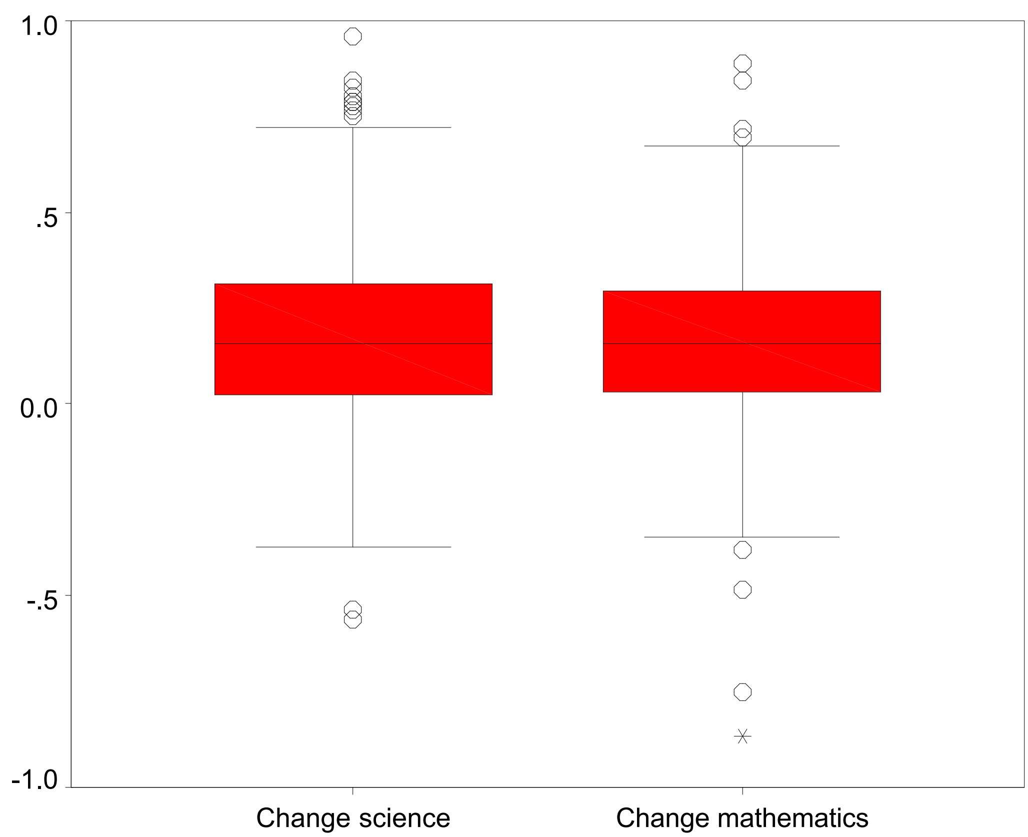
Program Variables

Curriculum Standards

One of the more easily measured key practices is whether students in participating sites are completing the *HSTW* recommended curriculum. Among other requirements, the *HSTW*-recommended curriculum calls for at least three credits each in mathematics and science, with two credits in each subject from courses with content equal to that of college preparatory mathematics and science courses. On average, there was a large increase in the percentage of students completing the SREB recommended coursework in science and mathematics. Figure 3 and Table 1 depict the distribution of schools on these two variables. The mean change was about +17 percentage points for both science and mathematics (see Figure 3 and Table 1). Not all changes were positive, however. A small percentage of schools (11 percent) had decreased by more than 10 percentage points the proportion of students completing the recommended curriculum.

Figure 3

Univariate Distribution of Changes in the Percentage of Students Completing the Recommended Curriculum in Science and Mathematics, by School: 1996 to 1998



Multivariate analysis. Increases in the proportion of students meeting *HSTW*'s curriculum standards had a large impact on achievement gains. Table 4 below displays the individual unstandardized regression coefficient in, the beta in, and the partial correlation coefficients for the two variables. Adding these variables into the equation as a set resulted in a significant increment in R^2 over the control model for each subject area.

They accounted for 4% more variance in science achievement, 8% in mathematics, and 5% in reading.

Examining individual variables, a 1-percentage-point change in the percentage of students completing the recommended mathematics curriculum was associated with a 1- to 2-point increase in science, mathematics, and reading test scores (1.16, 1.62, and 1.26 points respectively). For example, let's say that school A increased by 10 percent the percentage of students completing the recommended curriculum. One would then predict from the data that school A would also increase its average test score by 11 points—about one-half of one standard deviation.

Table 4
Regression Results of Changes in the Percentage of Students Completing Recommended Curriculum on Change in 1998 School Test Score Means, Controlling for Changes in Demographic Characteristics

Science	B[1]	Beta[2]	Partial Correlation[3]	R^2 added to control model
Change in % completing math curriculum	1.16	0.189**	0.242	
Change in % completing science curriculum	1.03	0.184**	0.237	
				0.038**
Mathematics	B[1]	Beta[2]	Partial Correlation[3]	R^2 added to control model
Change in % completing math curriculum	1.62	0.264**	0.336	
Change in % completing science curriculum	1.49	0.267**	0.343	
				0.076**
Reading	B[1]	Beta[2]	Partial Correlation[3]	R^2 added to control model
Change in % completing math curriculum	1.26	0.205**	0.224	
Change in % completing science curriculum	1.19	0.213**	0.234	
				0.049**

NOTE: ** $p < 0.01$, * $p < 0.05$, † $p < 0.10$.
[1] The unstandardized regression coefficient that would occur if that variable was entered into the model.
[2] The standardized regression coefficient that would occur if that variable was entered into the model.
[3] The correlation of the variable with the test score variable after removing the linear effect of the other variables in the control model.

Instructional Goals

Figure 4 and Table 1 display the distribution of seven variables that represent the change in the importance of certain instructional goals. All of the variables in this set were based on an item in the 1996 and 1998 teacher questionnaire that asked the following question:

How important are the following goals in your school?

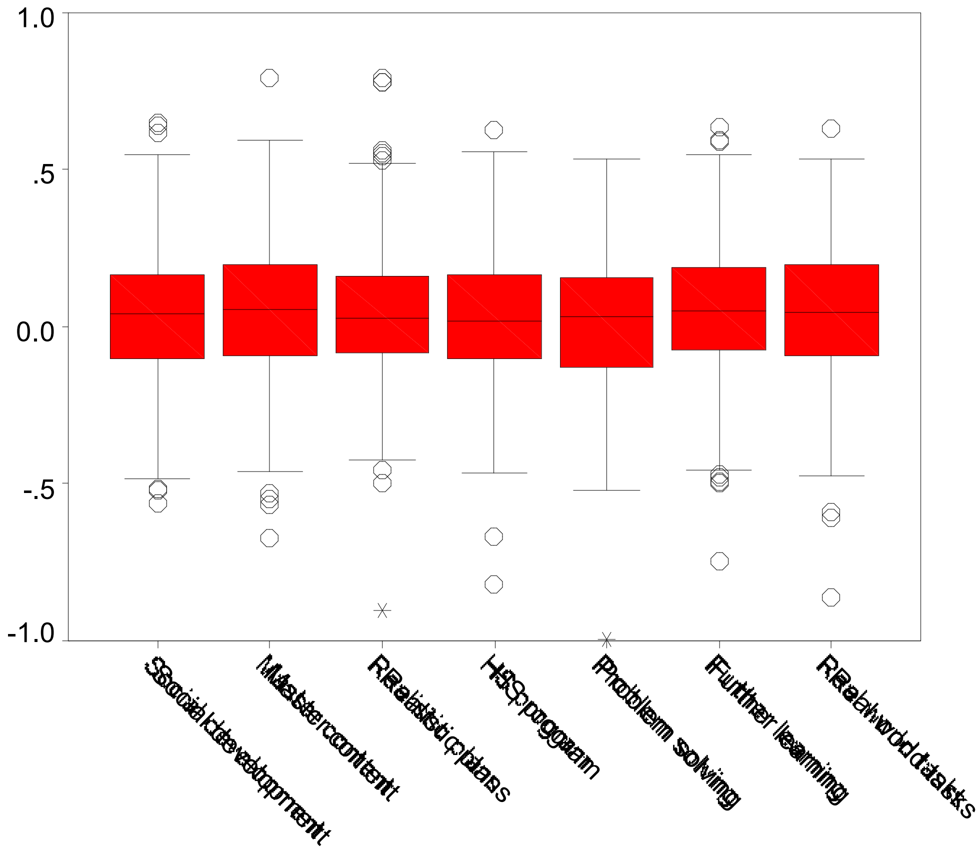
The goals listed in the questionnaire that were common to 1996 and 1998 are as follows:

- Help students in their social development by stressing the ability to get along with and understand others.
- Help all high school students master the essential content taught in college preparatory language arts, mathematics, and science courses.
- Help students make realistic plans for what they will do after graduation.
- Help students pursue a program of high school studies that will enable them to achieve their plans.
- Develop students' abilities to solve problems and think critically.
- Help students complete a program that prepares them for both employment and further learning.
- Encourage students' use of high-level academic content—language arts, mathematics, and science—in solving real-world problems.

Response categories ranged from 1 (*very important*) to 4 (*not at all important*).

On average, there was very little change between 1996 and 1998 on teacher ratings of these goals (see Figure 4). Mean change for these variables ranged from 0.02 to 0.03 points on the 4-point scale. One reason for this was that for many schools there was very little room for change. Mean rankings for these goals in 1996 was between *very important* and *important* (1.58 to 1.85). Almost all schools' teachers ranked these goals as important; even schools that had relatively low rankings for these goals gave them ranks of between *important* and *not too important*.

Figure 4
Univariate Distribution of Changes in the Importance Teachers Placed on Certain Instructional Goals, by School: 1996 to 1998



Multivariate analysis. Not surprisingly, given their low variances, these variables as a set did not add appreciably to the overall predictive power of the control equation. Taken together they added only 1 to 2% to the R^2 of the model (see Table 5).

Individually, these variables also did not add much to the prediction of gains in achievement. The one exception was the goal of helping students pursue a program of high school studies that will enable them to achieve their plans. A 1-unit change in the average ranking of this goal (e.g., from *not so important* to *important*) was associated with a 4- to 5-point gain in math and reading achievement (at the α=0.05 level).[8]

[8]Change in this goal was associated with science achievement at the α=0.10 level.

Table 5
Regression Results of Changes in the Importance of Instructional Goals on Change in 1998 School Test Score Means, Controlling for Changes in Demographic Characteristics

Science	B[1]	Beta[2]	Partial Correlation[3]	R^2 added to control model
Change in importance of goal:				
Social development	-0.72	-0.01	-0.02	
Master essential content	0.67	0.01	0.02	
Realistic plans	4.63	0.08*	0.11	
High school program to achieve their plans	4.10	0.06†	0.09	
Develop problem-solving and critical thinking	0.39	0.01	0.01	
Prepare all students for further learning	2.50	0.04	0.05	
High level academics in real world tasks and problems	4.81	0.08*	0.10	
				0.02

Mathematics	B[1]	Beta[2]	Partial Correlation[3]	R^2 added to control model
Change in importance of goal:				
Social development	-0.84	-0.01	-0.02	
Master essential content	-0.12	0.00	0.00	
Realistic plans	3.02	0.05	0.07	
High school program to achieve their plans	4.61	0.07*	0.10	
Develop problem-solving and critical thinking	0.01	0.00	0.00	
Prepare all students for further learning	2.54	0.04	0.06	
High level academics in real world tasks and problems	1.92	0.03	0.04	
				0.01

Reading	B[1]	Beta[2]	Partial Correlation[3]	R^2 added to control model
Change in importance of goal:				
Social development	-1.63	-0.03	-0.03	
Master essential content	0.22	0.00	0.00	
Realistic plans	3.93	0.07	0.08	
High school program to achieve their plans	5.46	0.09*	0.10	
Develop problem-solving and critical thinking	1.76	0.03	0.03	
Prepare all students for further learning	4.08	0.07	0.08	
High level academics in real world tasks and problems	5.12	0.08†	0.09	
0.02				

NOTE: ** p < 0.01, * p < 0.05, † p < 0.10.
[1] The unstandardized regression coefficient that would occur if that variable was entered into the model.
[2] The standardized regression coefficient that would occur if that variable was entered into the model.
[3] The correlation of the variable with the test score variable after removing the linear effect of the other variables in the control model.

Academic/Vocational Integration

Three variables comprised the set of variables we used to represent change in how much the school integrated academic instruction with the vocational curriculum. All three were based on items on the 1996 and 1998 student questionnaire. They were as follows:

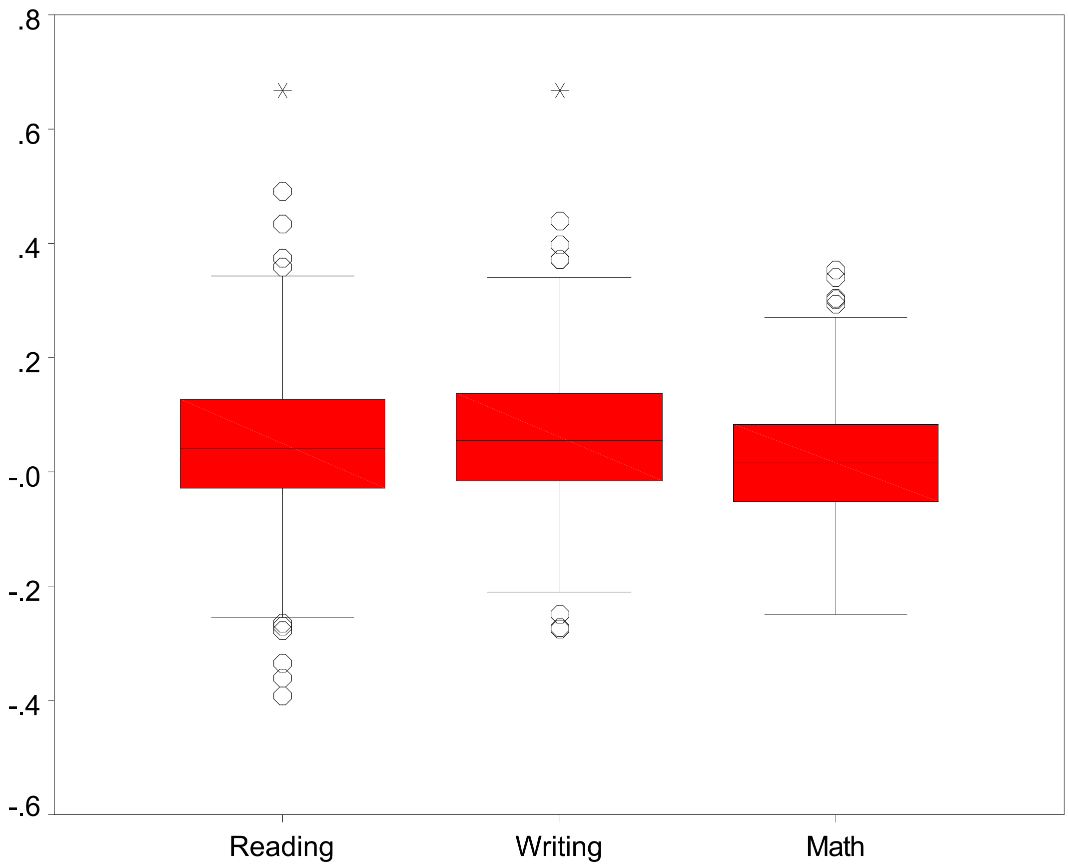
Did you feel your academic and vocational teachers *were working together* ***to improve your skills in the following areas?***

- Reading
- Writing
- Math

Students were asked to answer either *yes* (coded here as 1) or *no* (coded here as 0).

Figure 5 displays the distribution of these three variables. Table 1 (shown previously) gives the descriptive statistics for these variables. The baseline data in 1996 shows that on average these schools were engaged in a high degree of academic/vocational integration. On average, in 1996 schools had about 71 to 75% of their students responding that their academic and vocational teachers worked together to improve their academic skills. Nevertheless, there appears to be an overall increase in the amount of academic and vocational integration between 1996 and 1998. Mean change from 1996 to 1998 was 5% for teachers working together on reading skills, 6% on writing skills, and 2% for math skills.

Figure 5
Univariate Distribution of Changes
in Academic and Vocational Integration, by School: 1996 to 1998



Multivariate analysis. The introduction of this set of variables did not result in a significant increment in R^2 for science, mathematics, or reading (see Table 6); however, change in the proportion of students saying that their teachers worked together to improve their math skills added significantly to the prediction of mathematics achievement. Change in teachers' coordination to improve writing and reading skills added significantly to the prediction of gains in reading achievement.

Table 6
Regression Results of Changes in the Amount of Time Vocational and Academic Teachers Worked Together on Change in 1998 Mean Test Scores, Controlling for Demographic Characteristics

Science	B[1]	Beta[2]	Partial Correlation[3]	R^2 added to control model
Change in teachers working together to improve…				
Reading skills	0.23	0.022	0.030	
Writing skills	0.40	0.036	0.048	
Math skills	0.56	0.046	0.063	
				0.003

Mathematics	B[1]	Beta[2]	Partial Correlation[3]	R^2 added to control model
Change in teachers working together to improve…				
Reading skills	0.39	0.04	0.05	
Writing skills	0.48	0.04	0.06	
Math skills	1.20	0.10**	0.13	
				0.010

Reading	B[1]	Beta[2]	Partial Correlation[3]	R^2 added to control model
Change in teachers working together to improve…				
Reading skills	1.21	0.12**	0.14	
Writing skills	1.31	0.12**	0.14	
Math skills	0.84	0.07	0.08	
	0.017			

NOTE: ** $p < 0.01$, * $p < 0.05$, † $p < 0.10$.
[1] The unstandardized regression coefficient that would occur if that variable was entered into the model.
[2] The standardized regression coefficient that would occur if that variable was entered into the model.
[3] The correlation of the variable with the test score variable after removing the linear effect of the other variables in the control

In addition to statistical significance, the effect sizes of these variables were relatively large. In fact, they were almost as large as the effect sizes of changes in the percentage of students meeting or exceeding the *HSTW* curriculum standards. A 1% increase in the proportion of a school's students reporting that their academic and vocational teachers worked together to help improve their math skills resulted in a predicted 1.2-point increase in mathematics achievement. Likewise, a 1-point increase in the proportion of a school's students reporting teachers working together to improve reading and writing resulted in an increase of about 1.2 to 1.3% in reading achievement. This represents more than a one-to-one correspondence.

Guidance Counseling of Students

Two variables were used in this set. They were based on student responses to the following items in 1996 and 1998:

How much have you talked with the following people about planning your school program?

Choices included:

- A guidance counselor
- Teachers

Response categories were *not at all* (coded 1), *somewhat* (coded 2), and *a great deal* (coded 3). Figure 6 shows the univariate distribution of these two variables, while Table 1 (shown previously) displays the descriptive statistics.

On average, students within the *HSTW* schools had not talked very much with either their counselors or their teachers about their high school program. In 1996, the average student within a school had spoken with their counselor or teacher about their high school program only *somewhat* (mean=2.01 and 1.91 respectively). There also had been little or no change between 1996 and 1998 in the average amount of time students spent talking with their counselor or teacher (mean=0.02 and 0.05 respectively). Despite the small average difference between 1996 and 1998, some schools increased substantially the amount of time their students spent talking with their counselors and teachers, while others considerably decreased the amount of time their vocational completers spoke with these school personnel.

Figure 6

Univariate Distribution of Changes in the Proportion of Students Talking to their Counselor or Teacher about their High School Program, by School: 1996 to 1998

Multivariate analysis. There was a strong association of changes in the amount that students talked with a teacher or school counselor and changes in school achievement levels in science, mathematics, and reading. Controlling for demographic characteristics, those schools that increased the amount that students talked to teachers and counselors about their high school program increased their achievement rates; those that decreased this time had declines in their average achievement levels. The increment to the proportion of explained variance for the set of variables ranged from 3 to 4% (see Table 7). The effect sizes for the two variables were also relatively large, with standardized regression coefficients (Beta in's) ranging from 0.12 to 0.18. The unstandardized regression coefficients suggest that a 1-point change on this 3-point scale (e.g., from *not at all* to *somewhat*) was associated with an 8- to 11-point change in academic achievement.

Table 7
Regression Results of Changes in the Amount of Time Students Spent Talking with Counselors and Teachers About Their High School Plans, Controlling for Demographic Characteristics

Science	B[1]	Beta[2]	Partial Correlation[3]	R^2 added to control model
Change in talking about high school plans with…				
Counselor	7.85	0.141**	0.191	
Teacher	8.65	0.120**	0.162	
				0.025*

Mathematics	B[1]	Beta[2]	Partial Correlation[3]	R^2 added to control model
Change in talking about high school plans with…				
Counselor	8.45	0.15**	0.21	
Teacher	8.16	0.11**	0.15	
				0.026*

Reading	B[1]	Beta[2]	Partial Correlation[3]	R^2 added to control model
Change in talking about high school plans with…				
Counselor	9.93	0.18**	0.21	
Teacher	11.66	0.16**	0.19	
				0.04*

NOTE: ** p < 0.01, * p < 0.05, † p < 0.10.
[1] The unstandardized regression coefficient that would occur if that variable was entered into the model.
[2] The standardized regression coefficient that would occur if that variable was entered into the model.
[3] The correlation of the variable with the test score variable after removing the linear effect of the other variables in the control model.

Teacher Practices

Eight variables measuring teacher practice were common to the 1996 and 1998 teacher questionnaires. They were based on the following item:

To what extent has your emphasis on the following practices changed since your school became an SREB High Schools That Work site?

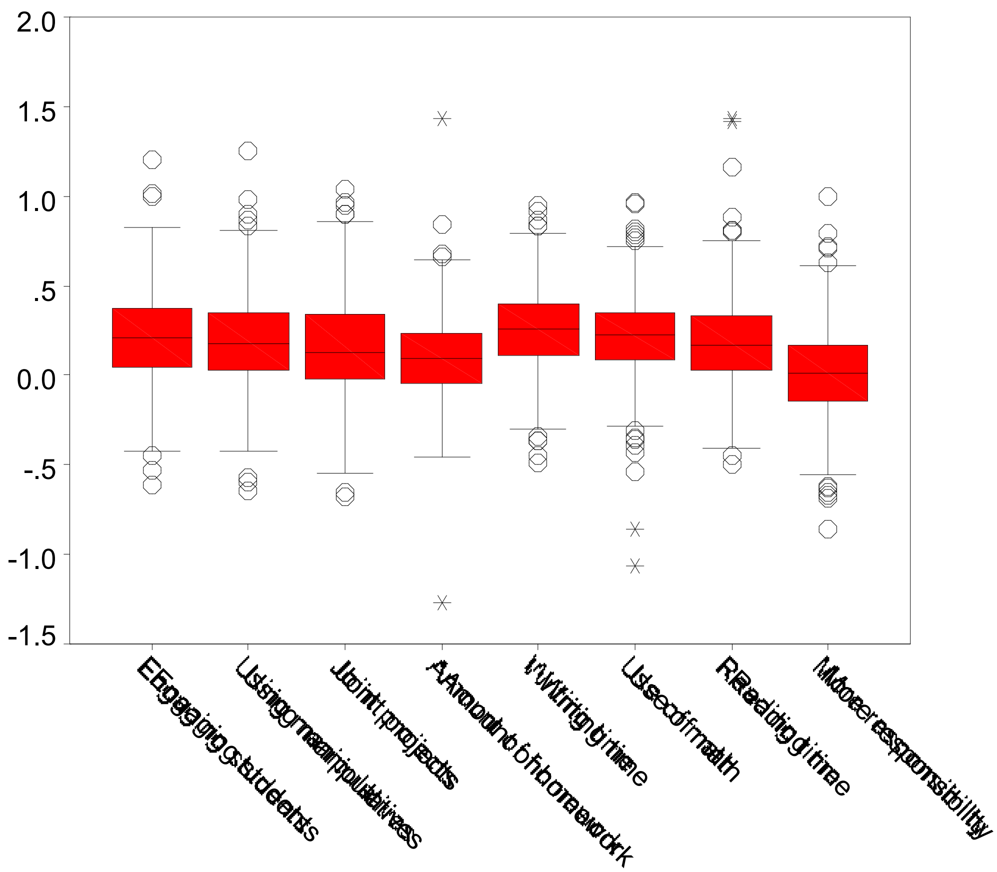
The practices included the following:

- Engaging students in learning activities that involve academic content
- Using manipulatives and hands-on experiments or projects to make content more concrete
- Students doing joint assignments in which they work with an academic and a vocational teacher

- Amount of homework assigned and reviewed
- Having students write to clarify and communicate their ideas
- Asking students to use mathematics to solve challenging real-world problems
- Amount of time students spend on assigned reading
- Students taking greater responsibility for their learning

Response categories ranged from 1 (*much less*) to 5 (*much more*), with 3 representing no change. Figure 7 displays the univariate distribution of these variables while Table 1 (shown previously) supplies descriptive statistics for these variables.

Figure 7
Univariate Distribution of Changes in Teacher Practices, by School: 1996 to 1998



The interpretation of these variables is a little tricky since teachers were asked in 1996 and 1998 how much their schools had changed practice and then we measured the difference in teachers' assessments between each period. Therefore, we are measuring the change in how much teachers think that change has occurred. Given this caution, on average, there was relatively little change within schools in teacher practices. On the 5-point scale used for these variables, average change was less than one-quarter of one point. Furthermore, even the maximum change was only about 1 1/2 points.

Multivariate analysis. Given this lack of variance, it is not surprising that changes in teacher practice did not have much impact on the prediction of school achievement levels. As a set, these variables did not add significantly to the R^2 of the model that contained only the control variables (see Table 8). The only variable within this set that seemed to have some limited impact was change in having students do joint projects. However, the statistical confidence of this finding was only at the α=0.10 level for mathematics and reading achievement.

Table 8
Regression Results of Changes in the Teacher Practices on Change in Mean Test Scores, Controlling for Changes in Demographics

Science	B[1]	Beta[2]	Partial Correlation[3]	R^2 added to control model
Change in teacher practice of:				
Engaging students in learning that involves academics	2.60	0.05	0.07	
Using manipulatives and hands-on projects to make content concrete	-0.87	-0.02	-0.02	
Having students do joint assignments	3.81	0.08*	0.11	
Amount of homework assigned and reviewed	3.20	0.06†	0.08	
Amount of time students write	2.14	0.04	0.05	
Amount of time students use math to solve real-world problems	2.32	0.04	0.06	
Amount of time students spend reading	1.09	0.02	0.03	
Getting students to take greater responsibility	1.33	0.03	0.04	
				0.02

Mathematics	B[1]	Beta[2]	Partial Correlation[3]	R^2 added to control model
Change in teacher practice of:				
Engaging students in learning that involves academics	1.15	0.02	0.03	
Using manipulatives and hands-on projects to make content concrete	-0.95	-0.02	-0.03	
Having students do joint assignments	2.68	0.06†	0.08	
Amount of homework assigned and reviewed	1.60	0.03	0.04	
Amount of time students write	2.06	0.04	0.05	
Amount of time students use math to solve real-world problems	1.76	0.03	0.05	
Amount of time students spend reading	0.41	0.01	0.01	
Getting students to take greater responsibility	1.38	0.03	0.04	
				0.01

Reading	B[1]	Beta[2]	Partial Correlation[3]	R^2 added to control model
Change in teacher practice of:				
Engaging students in learning that involves academics	3.26	0.07	0.08	
Using manipulatives and hands-on projects to make content concrete	0.29	0.01	0.01	
Having students do joint assignments	3.65	0.08†	0.09	
Amount of homework assigned and reviewed	3.96	0.08†	0.09	
Amount of time students write	3.03	0.05	0.06	
Amount of time students use math to solve real-world problems	4.50	0.09*	0.10	
Amount of time students spend reading	2.01	0.04	0.05	
Getting students to take greater responsibility	3.48	0.07	0.08	
				0.02

NOTE: ** $p < 0.01$, * $p < 0.05$, † $p < 0.10$.
[1] The unstandardized regression coefficient that would occur if that variable was entered into the model.
[2] The standardized regression coefficient that would occur if that variable was entered into the model.
[3] The correlation of the variable with the test score variable after removing the linear effect of the other variables in the control model.

Work-based Learning

Only two variables were available to be used to represent the key practice of work based learning. These were derived from items on the student questionnaire:

What best describes the amount of emphasis your vocational teachers placed on…having an expert outside the school evaluate [your] work, products, or accomplishments?

Response categories were *never required* (coded as 1), *required once or twice a year* (coded as 2), *required monthly or several times a year* (coded as 3), and *required daily or weekly* (coded as 4).

I participated in a work-based internship for which I completed a written and/or oral report

Response categories were *yes* (coded as 1) and *no* (coded as 0).

Figure 8 displays the univariate distribution of change in vocational teachers using outside experts while Figure 9 displays the same information for work-based internships. Table 1 presents descriptive statistics for these variables.

Figure 8
Univariate Distribution of Changes in Use of Outside Experts to Review Vocational Work and Projects, by School: 1996 to 1998

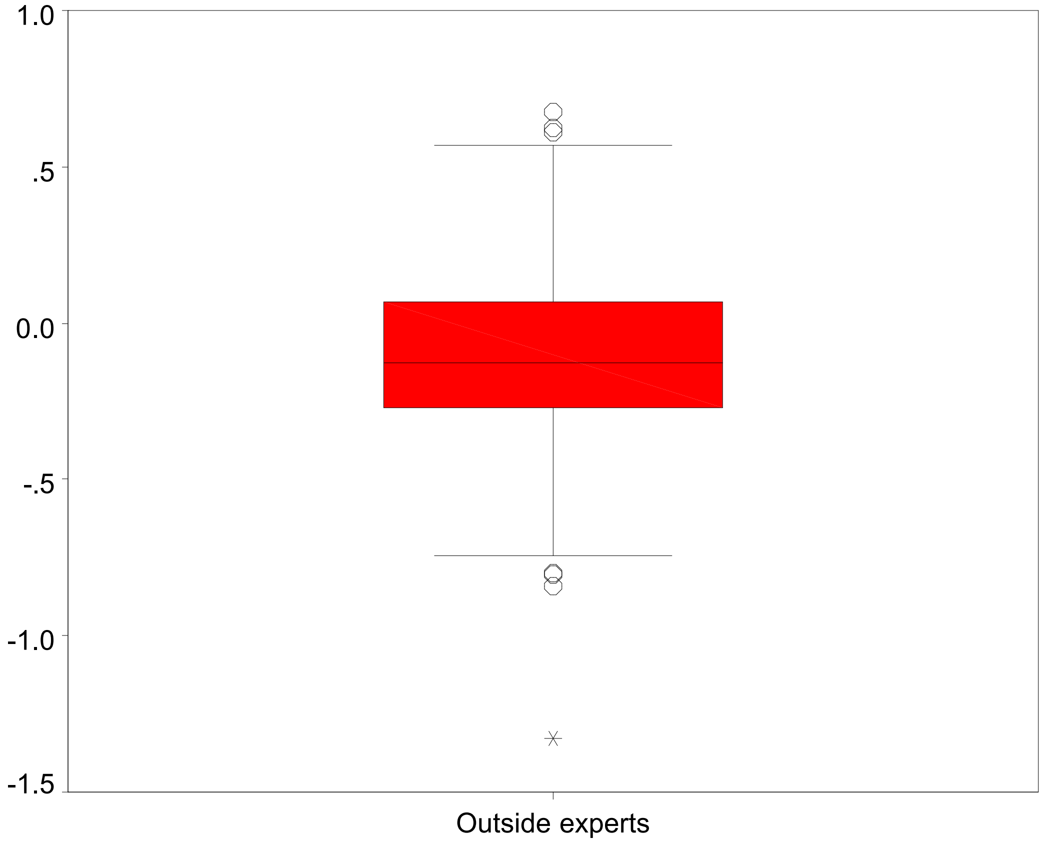
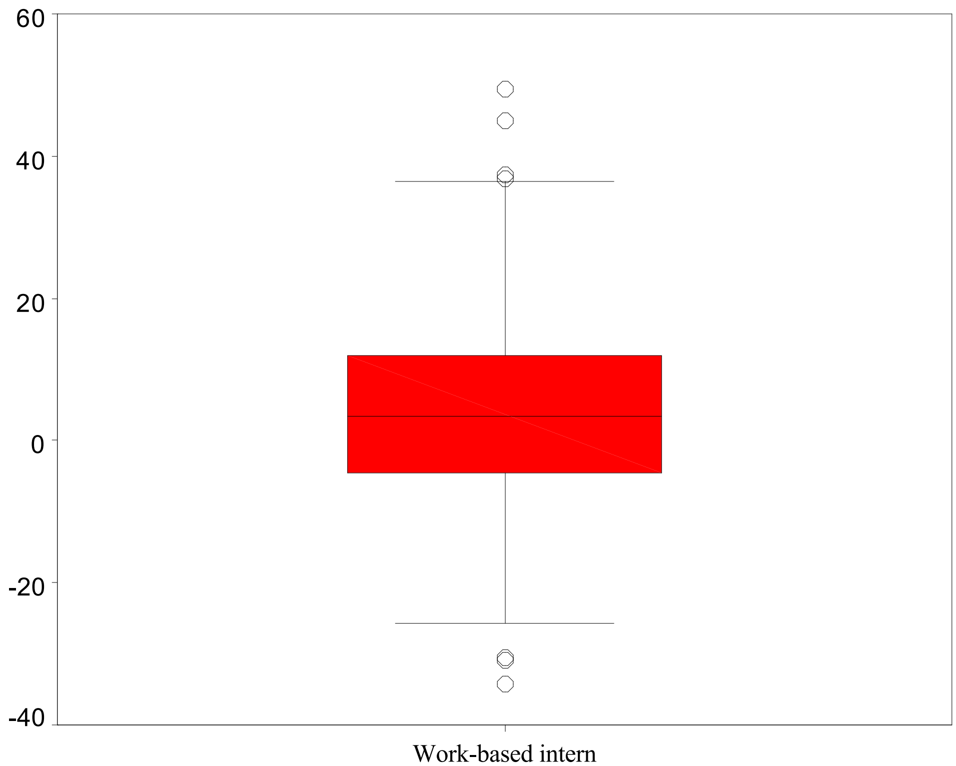


Figure 9
Univariate Distribution of Changes in Percentage of Vocational Completers Participating in Work-based Internships, by School: 1996 to 1998



A large percentage of vocational completers participated in a work based-internship in 1996 (about 31%). On average, within schools this percentage increased about 4 percentage points between 1996 and 1998—to approximately 35% in 1998. Having vocational work or projects reviewed by outside experts was a more rare event, relatively speaking. On average in 1996, schools had completers who reported either never having outside experts review their work or having this requirement only once or twice a year (mean=1.87 on the 4-point scale). There was little change in this mean ranking between 1996 and 1998 with a mean decrease of one-tenth of one point.

Multivariate analysis. These two variables did not significantly add to the explanatory power of the model for achievement in science, mathematics, or reading (see Table 9). However, for mathematics, the beta in for each variable was statistically significant and the effect was *negative* on achievement. Holding the demographic variables constant, increases in the proportion of work-based internships and increases in the time vocational teachers spent using outside experts to evaluate student work were associated with *decreases* in academic achievement.

Table 9
Regression Results of Changes in the Work-Based Learning Practices on Change in 1998 Mean Test Scores, Controlling for Changes in Demographics

Science	B[1]	Beta[2]	Partial Correlation[3]	R^2 added to control model
Vocational teacher emphasis on having outside expert evaluate work	-2.39	-0.050	-0.068	
Participated in work-based internship	-0.09	-0.085*	-0.114	
0.008				

Mathematics	B[1]	Beta[2]	Partial Correlation[3]	R^2 added to control model
Vocational teacher emphasis on having outside expert evaluate work	-5.16	-0.11**	-0.15	
Participated in work-based internship	-0.13	-0.12**	-0.17	
0.02				

Reading	B[1]	Beta[2]	Partial Correlation[3]	R^2 added to control model
Vocational teacher emphasis on having outside expert evaluate work	-2.47	-0.05	-0.06	
Participated in work-based internship	-0.09	-0.07	-0.07	
				0.01

NOTE: ** $p < 0.01$, * $p < 0.05$, † $p < 0.10$.
[1] The unstandardized regression coefficient that would occur if that variable was entered into the model.
[2] The standardized regression coefficient that would occur if that variable was entered into the model.
[3] The correlation of the variable with the test score variable after removing the linear effect of the other variables in the control model.

Complete Models

While the modeling approach we have used above has been simple, this approach has led us to more interpretable results; however, we also feel that it is worthwhile to assess the total impact on student achievement of the SREB key practices, *as measured in this analysis*. Therefore, in this section, the results of regressing science, mathematics, and reading achievement on the full array of variables used to represent the *HSTW* key practices are presented.

Tables 10, 11 and 12 present the control model (model 1) and the model with the full array of variables (model 2) for science, mathematics, and reading achievement, respectively. The *HSTW* key practices as measured in this analysis accounted for 13% of the variance between schools in their science and mathematics achievement scores, and 9% of the variance in reading achievement scores.

These are still fairly simple models in which all the relationships are hypothesized to be linear and we do not examine any interactions. Furthermore, the number of interrelated variables in this model make straightforward interpretations of the data difficult. For example, in the full model, there is a consistent and strong *negative* relationship between the use of manipulatives and changes in science, mathematics, and reading achievement. However, these same variables had virtually no relationship with gains in achievement in our simple models presented above (although the sign of the effects were the same). While it is always possible to find some post hoc explanation for this kind of result, it is difficult to imagine what theory would predict such an outcome. Given the complexity of the interrelationships between these variables and a lack of theory on how they would interact, we feel that the simple models presented in this study are much more useful.

Table 10
Results of Full Regression Model of Key Practices Variables on Change in 1998 Science Test Scores

	Model 1		*Model 2*	
	B	Beta	B	Beta
(Constant)	151.58		129.17	
1996 test	0.38	0.33**	0.46	0.40**
Percent minority 1998	-24.91	-0.53**	-28.56	-0.60**
Percent minority 1996	18.47	0.38**	23.81	0.49**
Mean fathers' educational level 1998	10.25	0.25**	7.39	0.18*
Mean fathers' educational level 1996	0.92	0.02	3.79	0.09
Mean mothers' educational level 1998	2.91	0.06	0.62	0.01
Mean mothers' educational level 1996	-2.24	-0.05	-1.42	-0.03
Change in % completing math curriculum			7.56	0.11*
Change in % completing science curriculum			6.68	0.11*
Change in importance of goal:				
Social development			-6.55	-0.09†
Master essential content			-4.38	-0.06
Realistic plans			-2.36	-0.03
High school program to achieve their plans			7.38	0.10
Develop problem-solving and critical thinking			-5.36	-0.07
Prepare all students for further learning			4.08	0.06
High level academics in real world tasks and problems			8.16	0.11†
Change in teachers working together to improve:				
Reading skills			8.15	0.07
Writing skills			5.18	0.04
Math skills			-2.97	-0.02
Change in talking about high school plans with				
Counselor			6.58	0.11*
Teacher			9.04	0.11*
Change in teacher practice of:				
Engaging students in learning that involves academics			-1.33	-0.02
Using manipulatives and hands-on projects to make content concrete			-8.99	-0.15**
Having students do joint assignments			1.26	0.02
Amount of homework assigned and reviewed			2.07	0.03
Amount of time students write			-2.29	-0.03
Amount of time students use math to solve real-world problems			5.42	0.08
Amount of time students spend reading			-0.67	-0.01
Getting students to take greater responsibility			7.16	0.12*
Voc'l teacher emphasis on having outside expert evaluate work			-2.83	-0.05
Participated in work-based internship			-0.09	-0.08†
Total R^2		0.271**		0.398**
Incremental R^2		0.271**		0.127**

NOTE: ** $p < 0.01$, * $p < 0.05$, † $p < 0.10$.

Table 11
Results of Full Regression Model of Key Practices Variables on Change in 1998 Mathematics Test Scores

	Model 1		*Model 2*	
	B	Beta	B	Beta
(Constant)	178.99		152.53	
1996 test	0.37	0.43**	0.46	0.54**
Percent minority 1998	-20.77	-0.49**	-21.72	-0.51**
Percent minority 1996	11.53	0.27*	14.29	0.33**
Mean fathers' educational level 1998	12.83	0.34**	8.72	0.23**
Mean fathers' educational level 1996	-0.14	0.00	1.87	0.05
Mean mothers' educational level 1998	4.57	0.10	2.61	0.06
Mean mothers' educational level 1996	-6.13	-0.14†	-3.78	-0.09
Change in % completing math curriculum			9.32	0.15**
Change in % completing science curriculum			7.73	0.14**
Change in importance of goal:				
Social development			-2.41	-0.04
Master essential content			-2.43	-0.04
Realistic plans			-0.82	-0.01
High school program to achieve their plans			6.33	0.09†
Develop problem-solving and critical thinking			-5.83	-0.09†
Prepare all students for further learning			3.16	0.05
High level academics in real world tasks and problems			2.77	0.04
Change in teachers working together to improve:				
Reading skills			-1.38	-0.01
Writing skills			1.39	0.01
Math skills			7.78	0.06†
Change in talking about high school plans with:				
Counselor			5.52	0.10**
Teacher			5.48	0.08*
Change in teacher practice of:				
Engaging students in learning that involves academics			-0.52	-0.01
Using manipulatives and hands-on projects to make content concrete			-7.30	-0.14**
Having students do joint assignments			1.34	0.03
Amount of homework assigned and reviewed			0.65	0.01
Amount of time students write			0.05	0.00
Amount of time students use math to solve real-world problems			3.10	0.05
Amount of time students spend reading			-0.80	-0.01
Getting students to take greater responsibility			3.47	0.06
Voc'l teacher emphasis on having outside expert evaluate work			-3.82	-0.08*
Participated in work-based internship			-0.10	-0.10**
Total R^2		0.483**		0.614**
Incremental R^2		0.483**		0.131**

NOTE: ** $p < 0.01$, * $p < 0.05$, † $p < 0.10$.

Table 12
Results of Full Regression Model of Key Practices Variables on Change in 1998 Reading Test Scores

	Model 1		*Model 2*	
	B	Beta	B	Beta
(Constant)	154.98		132.50	
1996 test	0.44	0.38**	0.51	0.44**
Percent minority 1998	-25.36	-0.60**	-27.27	-0.64**
Percent minority 1996	13.41	0.31**	16.70	0.39**
Mean fathers' educational level 1998 *	9.10	0.24**	6.29	0.17
Mean fathers' educational level 1996	1.23	0.03	2.98	0.08
Mean mothers' educational level 1998	5.57	0.13†	4.17	0.10
Mean mothers' educational level 1996	-4.70	-0.11	-2.57	-0.06
Change in % completing math curriculum			7.36	0.12**
Change in % completing science curriculum			4.40	0.08†
Change in importance of goal:				
Social development			-2.89	-0.04
Master essential content			-2.80	-0.04
Realistic plans			3.33	0.05
High school program to achieve their plans			2.11	0.03
Develop problem-solving and critical thinking			-7.36	-0.11*
Prepare all students for further learning			1.52	0.02
High level academics in real world tasks and problems			8.86	0.13*
Change in teachers working together to improve:				
Reading skills			-2.43	-0.02
Writing skills			1.47	0.01
Math skills			1.52	0.01
Change in talking about high school plans with:				
Counselor			4.50	0.08*
Teacher			6.30	0.09*
Change in teacher practice of:				
Engaging students in learning that involves academics			1.39	0.03
Using manipulatives and hands-on projects to make content concrete			-8.16	-0.16**
Having students do joint assignments			2.73	0.06
Amount of homework assigned and reviewed			1.73	0.03
Amount of time students write			-0.70	-0.01
Amount of time students use math to solve real-world problems			2.04	0.04
Amount of time students to spend reading			-0.43	-0.01
Getting students to take greater responsibility			2.14	0.04
Voc'l teacher emphasis on having outside expert evaluate work			-1.66	-0.03
Participated in work-based internship			-0.08	-0.08*
Total R^2		0.472**		0.562**
Incremental R^2		0.472**		0.090**

NOTE: ** $p < 0.01$, * $p < 0.05$, † $p < 0.10$.

However, it is reassuring that given all of these caveats that the main findings of our simple descriptive models hold when examined in the context of these more complete models. In these more complete models, an increase in the percentage of students meeting the recommended curriculum requirements and an increase in the amount of time students spent talking with counselors and teachers about their high school plans had a positive effect on science, mathematics, and reading achievement. The negative relationship between the variables used to measure work-based learning and achievement was also confirmed in these more elaborate models.

DISCUSSION

In this analysis, we have examined several clusters of key practices that comprise the reform methods endorsed by the *HSTW* network and assessed their impact on academic achievement. Because of the large number of recommended reform methods and the large number of variables that could be used to represent these methods, we have tried to particularly careful in using simple and direct analytical methods. We have chosen to examine simple models rather than over-complex explanatory models. We did this to educe some broad generalizations about key aspects of the *HSTW* effort without making claims to a degree of scientific rigor that was not practical nor warranted by the nature of the data that we used.

In light of this, we would also like to reiterate our cautionary note about the nature of the data that we used in this analysis. These data were not collected for the purpose of an overall evaluation of the theoretical underpinnings of the *HSTW* reform effort. Furthermore, for many of the clusters of key practices within *HSTW*, we found only a limited number of variables common to the 1996 and 1998 surveys that we could use to operationalize the practice. The data are also not longitudinal, and this introduces additional concerns about cause and effect relationships. Furthermore, we would like to emphasize that we looked only at *academic* achievement. Many of the reforms we examine may be targeted at other outcomes (such as occupational outcomes) and not at academic achievement per se.

Nevertheless, we did find evidence for the effectiveness of several key practices within the constellation of factors that comprise the *HSTW* reform effort. Specifically we found that independent of schools' demographic profile (or changes therein) the following factors are associated with gains in academic achievement:

(1) An increase in the percentage of vocational completers within the school that complete a rigorous course of study in science and mathematics

(2) An increase in the frequency with which vocational completers speak with their counselor or teacher about their high school program

We also found evidence for the effectiveness of integrating academic content into the vocational curriculum. Increases in the proportion of students within a school saying that their academic and vocational teachers were working together to improve their math skills were associated with gains for those schools in mathematics. Similarly, there was an increase in reading achievement in those schools for which there was an increase in the proportion of students who felt their academic and vocational teachers were working together to improve their reading and writing skills. There were also limited and tentative indications that increasing the proportion of students doing joint projects in which the student works with both a vocational and academic teacher improved a school's academic achievement.

Our findings also suggest that schools that are implementing work-based training or internships should look carefully at how they implement these programs. The results of this analysis suggest that these efforts may not pay off in terms of gains in achievement. In the schools that we examined here, there was a clear negative association of more students participating in these programs with lower achievement levels.

In any analysis of schools, however, the direction of cause and effect can be difficult to determine. It may be that lower achieving students are more likely to enroll in work-based internships. Since the data we used here are not longitudinal, an increase within a school in the proportion of vocational students in work-based internships may reflect changes in the composition of their vocational students and not changes in policy. Therefore, schools that have more vocational completers participating in work-based internships in 1998 than in 1996 may have lower achievement levels due to these changes in the prior achievement levels of their vocational students and not due to changes in policy.

Of course, the problem with the direction of cause and effect is present in the interpretation of those practices we found that we cautiously interpreted as signs of *positive effects* of the *HSTW* reform effort. However, we have tried to model changes in the composition of the schools' vocational students with the control variables introduced into our models. While these controls are imperfect, the variables we used are traditionally correlated very highly with prior academic achievement. We also chose to examine the *HSTW* practices with simple models in the hope that this would minimize other confounding effects.

We chose to use data that had previously been collected by the schools within the *HSTW* network. These data were used by the schools for internal monitoring and were not specifically designed for evaluative purposes. As we mentioned earlier, these kinds of data are being collected at the local level at an ever-increasing frequency. While our primary goal of this study is to examine the correlates of success in the *HSTW* network, we also hope that our methods will stimulate others to think about how this kind of data could be used for research.

Because of the limitations of the methods and data that we used, we were cautious about overinterpreting the results of the analysis; however, because the models *were* simple, we feel that they are all the more worthwhile to practitioners. Coupled with other quantitative and qualitative information, these results can be used by *HSTW* to focus their attention on particular aspects of their program.

Sir Isaiah Berlin (1996) made the now famous distinction between understanding and knowledge—understanding involves insight into the world; knowledge involves only the accumulation of facts. We hope that the results presented in this paper will lead to policymakers and researchers building up a reservoir of relevant information that will lead to an understanding of how schools work and how to improve them.

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APPENDIX

HSTW KEY PRACTICES

Binding the *HSTW* schools together is their willingness and effort to enact the following set of ten key practices, which aim to improve student performance by blending higher level academic studies and challenging career studies:

- Set high expectations and have career-bound students meet them.
- Increase access to challenging vocational and technical studies and emphasize the use of high-level academic skills in the context of the modern workplace and in preparation for continued learning.
- Increase access to academic studies that teach the essential concepts from the college preparatory curriculum through functional and applied strategies that enable students to see the relationship between course content and their future.
- Have students complete a challenging program of study with an upgraded academic core and a major. The academic core includes at least four years of college preparatory English and three years each of mathematics and science, with at least two years in each area equivalent in content to courses offered in the college preparatory program. The major includes at least four Carnegie units in a career or academic major and two Carnegie units in related technical core courses.
- Provide students with access to a structured system of work-based and school-based learning—secondary and postsecondary—collaboratively planned by educators, employers, and workers.
- Have an organizational structure and schedule that enables academic and vocational teachers to have the time to plan and provide integrated instruction.
- Have each student actively engaged in the learning process.
- Involve each student and his or her parent(s) in a career guidance and individualized advisement system.
- Provide a structured system of extra help to enable career-bound students to successfully complete an accelerated program of study that includes high-level academic content and a major.
- Use student assessment and program evaluation data to continuously improve curriculum, instruction, school climate, organization, and management to advance student learning.