Examining the Implementation and Effectiveness of a District-Wide Instructional Improvement Effort

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The improvement of urban education has been a key battleground in the past decade of school reform. While most improvement efforts have been aimed at high-poverty urban schools, strategies for reforming entire districts have recently attracted the attention of prominent panels (Education Week, 2000) and researchers (e.g., Bryk, Sebring, Kerbow, Rollow, & Easton, 1998; Elmore & Burney, 1999; Knapp & McLaughlin, 1999; Talbert & Wechsler, 1999; Stein & D'Amico, 2000a). One of the biggest challenges associated with district-wide models of reform is the need to systemically grapple with issues of scale (reaching every school and every classroom) while at the same time honoring the variability that inevitably exists among the schools, classrooms, teachers, and students in any given district. One-size-fits-all, district-imposed models rarely work; models built entirely from the ground up by individual schools can also be problematic, however, as individual schools rarely possess the resources or expertise to mount comprehensive reform efforts.

The purpose of the present study is to examine the implementation and effectiveness of one particular urban district's improvement efforts. It is part of a five-year study of New York City's Community School District #2 and its multi-faceted strategy for continuous instructional improvement. District #2 is one of 32 community school districts in New York City with boundaries that encompass major cultural institutions, wealthy residential and commercial areas, historic neighborhoods, and some of the most densely populated poor communities in Manhattan. The district includes affluent and middle class neighborhoods on the upper east side, diverse mid-town neighborhoods, Chinatown, Greenwich Village, Little Italy, Tribeca, and Hell's Kitchen, all of which include both middle class enclaves and neighborhoods with substantial concentrations of lower income families and recent immigrants (Elmore & Burney, 1997).

Like all of New York City's community school districts, District #2 primarily serves students in kindergarten through eighth grade. Enrollment in the district has grown steadily in recent years due to immigration and the return of middle class students to public schools, from 21,304 in the 1996-97 school year to 22,588 in 1999-00. As of the 1999-00 school year, approximately 66% of the students were enrolled in kindergarten through fifth grade, while 30% were enrolled in grades

six through eight.[1] The district's 44 schools are configured in a variety of ways, the most common of which are PK/K–5 (21 schools), 6-8 (10 schools), PK/K-8 (5 schools) and 6-12 (5 schools). The size of these schools varies widely, from less than 100 students in some of the specialty alternative schools, to more than 1000 in comprehensive middle schools. This wide variation in both school composition and student needs is one of the major challenges facing District #2's reform efforts.

The diagram shown in Figure 1 is our representation of District #2's strategy for accomplishing district-wide improvement. Their improvement strategy includes both common goals and a system of support and accountability that is tailored to individual schools, teachers, and students. This strategy drives their major subject-matter initiatives in literacy and mathematics, which in turn shape professional development, classroom instruction, and (hopefully) leads to improvements in student achievement.

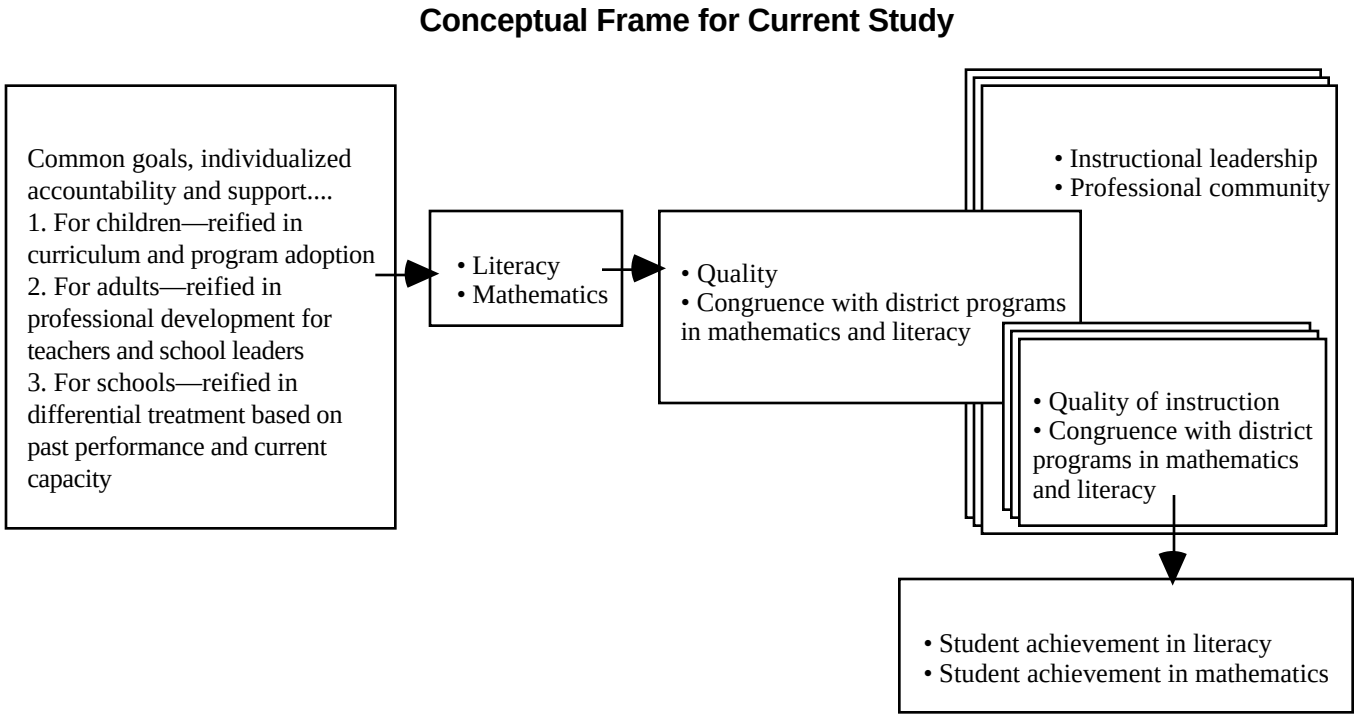

Figure 1: Conceptual Frame for Current Study

Three underlying principles drive District #2's improvement strategy. First, the ultimate focus at all levels of the system should be on instructional improvement (Elmore & Burney, 1999). Unlike many districts in which upper levels of the organization are far removed from the details

[1] The remaining 4% of the students were in grades 9-12. Grades 9-12 are organized as small alternative schools serving specialized groups of students.

of instructional practice, in District #2 the kinds of learning opportunities provided to students in classrooms is viewed as everyone's concern—from the teacher to the principal to the deputy superintendent to the superintendent him or herself. A corollary to this principle is that effective instructional practice depends on capable principals who serve as instructional leaders, supporting teachers in the development of quality practice, arranging for professional development, and encouraging a sense of professional community in the school building (Stein, D'Amico & Israel, 1999; Stein & D'Amico, 2000b).

Second, instructional improvement is viewed as being greatly enhanced by the adoption of district-wide instructional frameworks. Rather than each teacher discovering, developing, or adapting his or her own pedagogical approach to the teaching of reading and mathematics, District #2's philosophy is that students and teachers benefit when the entire district adopts a common framework in these major subject areas. In the late 1980s and early 1990s, the district invested considerable time and resources into the development of Balanced Literacy as a framework for the teaching of reading and writing in the elementary grades (Stein, D'Amico & Johnstone, 1999; Stein, D'Amico & Israel, 1999). Starting in the mid-nineties, they adopted a common mathematics curricula, TERC's *Investigations*, for these grades (Stein & D'Amico, 2000b; Hudson, 2000). It is important to note that the district's promotion of common instructional frameworks goes beyond simple mandates. They've committed significant resources (materials, professional development for teachers and principals), developed models of best practice (e.g., a Professional Development Laboratory), and created an accountability system that expects teachers to implement what they've learned. Together, these actions are meant to harness significant staff energy toward the effective implementations of these programs district-wide.

Finally, the district recognizes the tension that exists between common frameworks and the need for local school autonomy. Indeed, conventional wisdom in educational circles is that district imposition of common instructional approaches is antithetical to teacher professionalism, shared ownership, and motivation for reform. Within District #2, this concern is exacerbated by an exceedingly wide range of school contexts making up its system of elementary and middle schools.

District #2's twenty-eight elementary schools vary substantially in their student and teacher composition as well as their overall progress with respect to the Literacy and Mathematics Initiatives. The number of students in kindergarten through grade five who were eligible for free or reduced price lunch in 1999-2000 ranged from as little as 10% in some schools to as much as 99% in others. Likewise, the number of students with limited proficiency in English in each

school ranged from less than 1% to as much as 32%. Ethnic composition of the schools also ranges broadly, with some schools consisting largely of Asian students (e.g. 93%), others of White (e.g. 79%) or Hispanic students (66%), and still others with highly mixed populations.

As a result, the schools and classrooms within District #2 vary quite dramatically in terms of the needs and proficiencies of their students, teachers and principals with respect to literacy and mathematics. District #2's reaction to this variation has been to create support and supervision structures that attempt to individualize assistance as much as possible (Elmore & Burney, 1997). Ideally, students receive instruction tailored to their needs, teachers receive professional development within their classrooms and tied to their particular conditions, and principals work directly with district leaders on strategies to improve teaching and learning in their particular schools.

PURPOSE OF THE CURRENT STUDY

With data collected on the key components of District #2's improvement strategy as represented in Figure 1, we examine two major research questions:

> *Implementation of District #2's Improvement Strategy:* What is the relationship among selected components of District #2's improvement strategy, particularly instructional leadership, school professional community, professional development and classroom instruction?
>
> *Effectiveness of District #2's Improvement Strategy:* What effects do the components of District #2's improvement strategy have on student achievement?

Previous investigations focused largely on the effects of the professional development component of District #2's overall strategy on student achievement. Using schools as the unit of analysis, Resnick and Harwell (1998) suggested that the quality of professional development in schools (as judged by the Deputy Superintendent and the Director of Professional Development) was positively and indirectly related to the achievement of students in those schools through its affect on the quality of teaching. Another study by Stein, Harwell and D'Amico (1999) found that schools in the Focused Literacy Network, a network of schools with historically low scores in reading that received extra attention and resources to improve their performance, had greater gains on reading tests between 1997 and 1998 than did other elementary schools in the district. A key part of the extra support these schools received was more extensive and targeted professional development experiences for their teachers. Like the Resnick and Harwell study, Stein, Harwell and D'Amico relied on school aggregate data. In contrast, a study by Harwell, D'Amico, Stein,

and Gatti (2000) used multilevel models and found little relationship between teachers' self-reported engagement in professional development and student achievement.

The study reported here takes into account a greater portion of District #2's reform strategy than professional development alone. Multilevel analyses are conducted to trace the relationships between key components of District #2's improvement strategy and student achievement in both literacy and mathematics. These components include:

Instructional Leadership	The quality of instructional leadership in literacy and mathematics provided to teachers by their principals;
Professional Community	The strength of the professional community in each school;
Professional Development	The quality of professional development provided to teachers and its connection to the district's core instructional programs in literacy and mathematics;
Classroom Instruction	The quality of classroom instruction in both literacy and mathematics and its alignment with the district's core instructional programs in these subjects.

The larger proportion of District #2's strategy measured should lead to a more comprehensive picture of their improvement plans and their effectiveness than was possible in previous studies.

METHODS

Data sources

The bulk of the data reported herein was collected during the 1999-2000 school year. Key sources include student achievement and demographic data maintained by the New York City Board of Education and questionnaires administered to teachers and principals throughout District #2. The questionnaires were used to collect information on the school and classroom variables described earlier—classroom instruction; professional development; instructional leadership; and professional community. Table 1 summarizes the relationship between data sources and variables. Details of the data collected follow.

Table 1: School- and classroom-level data sources and variables for the 1999-2000 HPLC achievement study

Variables	Data Sources: Teachers	Data Sources: Principals
Quality of Instructional Leadership	X	
Strength of School Professional Community	X	
Professional Development		
• Alignment with Balanced Literacy/TERC's *Investigations*	X	
• Quality	X	
Classroom Instruction		
• Quality		X
• Alignment w/District #2 programs		X
• Role of Balanced Literacy/TERC's *Investigations* in teachers' work	X	

Student demographics and achievement

Achievement and demographic data for individual students in District #2 was made available through the Division of Assessment and Accountability of the Office of the Deputy Chancellor of Instruction of the New York City Board of Education. The information obtained included the ethnicity and gender for every student, eligibility for a free or reduced priced lunch, English proficiency status, attendance rates, and achievement scores in reading and mathematics.

Achievement data of some kind is available for District #2 students in grades three through eight. Unfortunately, achievement data in literacy and mathematics for students in grades six through eight cannot be linked directly with their mathematics and English language arts teachers. As a result, our analyses are limited to the 7092 students enrolled in grades three through five during the 1999-00 school year. Third- and fifth-grade students' reading achievement is measured by the Comprehensive Test of Basic Skills (CTB); their mathematics achievement is measured by the Terra Nova exam, also published by CTB. Fourth-grade student achievement is measured by the New York State performance assessments in English Language Arts and mathematics.[2]

[2] In 1998-99 New York State introduced a new set of performance assessments in English language arts and mathematics that must be taken in fourth grade. As a result, the city no longer requires 4th grade students to take the CTB tests.

Teacher questionnaires

Information on teachers' backgrounds and professional development experience was obtained via a questionnaire. In early May of the 1999-2000 school year, questionnaires were sent to teachers in all of District #2's schools. By the end of the school year, questionnaires had been received from 286 teachers, a response rate of approximately 26%. 82 of these teachers are regular classroom teachers in grades 3 through 5 and thus their responses can be linked with student achievement data. In Appendix A, we summarize the subset of the questions used in the analyses reported here. The entire questionnaire is available as an appendix to D'Amico, van den Heuvel, and Harwell (2000).

The questionnaire is divided into several sections. Teacher responses to six sections of the questionnaire form the core of the analyses and findings discussed in this paper: Education and Background; Teaching Experience; Your Principal; Professional Community in Your School; Professional Development in Literacy; and Professional Development in Mathematics. Their responses to the items in the first two sections provided basic demographic information, such as the number of years they have been teaching or their ethnicity. In the section entitled, *Your Principal*, teachers rated the instructional leadership of their principal in literacy and mathematics and his/her ability to communicate with teachers. In the section entitled, *Professional Community in Your School*, teachers responded to six Likert-type items which asked them to rate the quality and strength of different aspects of their school community.

In the section on *Professional Development in Literacy*, teachers were asked to comment on the quality of the professional development they had received in literacy and the role that the Balanced Literacy program in District #2 played in their professional development and teaching experiences. Teachers were asked to rate the quality of their professional development with respect to its effectiveness in addressing important features of teachers' professional knowledge and skills, such as, the learning-to-read process, classroom assessment, and effective instructional practices for supporting the learning-to-read process. They were also asked to comment on the pervasiveness of the Balanced Literacy framework in their day-to-day professional lives (e.g., how directly tied their professional development was to Balanced Literacy, how important it was to their principal that they incorporate Balanced Literacy into their instruction). In the section on *Professional Development in Mathematics*, the teachers were asked a parallel set of questions in mathematics to those on professional development in literacy.

All ratings provided by the teachers were on a five-point Likert scale in which a "5" indicated a very positive opinion on the part of the teacher and a "1" indicated a negative one. Single

constructs (corresponding to five of the variables listed in the first column of Table 1) were created from the ratings of related items—first conceptually, then confirmed via factor analysis. (See Appendix B for more details.) For example, all six items of the school professional community section were found to cluster together and hence formed the construct "Strength of School Professional Community.". These constructs—Strength of School Professional Community; Quality of Professional Development in Literacy; Quality of Professional Development in Mathematics; Role of Balanced Literacy; Role of TERC's *Investigations*—were then used in the analyses presented here. The rest of the variables listed in the first column of Table 1 were represented by single items on the questionnaire. (See Appendix A for a list of which items formed constructs and which ones were used alone.)

Principal questionnaires

Twenty-five principals in the district also completed questionnaires in the spring of 2000, twenty from elementary schools and five from middle and/or high schools. The principal questionnaire consisted of a subset of the questions on the teacher questionnaire and a few additional questions.[3] The additional questions asked to the principals rate each teacher in the school with respect to the quality of their literacy and mathematics instruction and the alignment of that instruction with the Balanced Literacy program and the *Investigations* curriculum. These ratings are the only portion of the questionnaire used in the analyses reported here. Five of the principals who returned surveys did not complete the teacher ratings. Twenty of the principals completed the teacher ratings section, leading to ratings for 297 elementary school teachers, 118 of which can be linked to student achievement data.

Data sample

Our analyses are based on a subset of the data resulting from the intersection of key data sources—in particular, those teachers and students for whom both student achievement data and a completed teacher questionnaire were available.[4] As shown in Table 2, there were 4666 students enrolled in grades three and five in District #2 and 2426 in fourth grade. Slightly more than 90% of these students sat for the achievement tests. Of these, just over 1300 students in 57 classrooms both took the CTB exams in reading and mathematics *and* had teachers who turned in

[3] The full survey is available as an appendix to (D'Amico, van den Heuvel and Harwell, 2000).

[4] Several of the teachers who filled out a questionnaire performed specialized teaching, such as teaching music or special education classes. We omitted these teachers from our final sample. Moreover, while some student data were available for more than 1000 teachers in PK-12 in District #2 in the 1999-00 school year, student achievement data could only be linked to the 328 elementary teachers in grades three through five.

a survey. Just over 600 students in 26 classrooms both took the state test in English language arts or mathematics *and* had teachers who turned in a survey.

Table 2: Number of students in the sample used for data analysis

	Students enrolled	Students with test scores	Students linked to teachers who turned in surveys	
			Students	Classrooms
Literacy: CTB (grades 3 & 5)	4666	4226	1315	57
Literacy: State (grade 4)	2426	2189	616	26
Mathematics: CTB (grades 3 & 5)	4666	4221	1313	57
Mathematics: State (grade 4)	2426	2199	620	26

Table 3: Comparisons of students throughout District #2 in grades 3-5 to those in the samples

	Grades 3 and 5		Grade 4	
	Not in sample (n = 3347)	Sample (n = 1319)	Not in Sample (n =1803)	Sample (n = 623)
Eligible for free/reduced price lunch	62.6%	51.5%	62.7%	49%
English Language Learners	13.2%	2%	12.5%	3.2%
Ethnicity				
Asian	36.8%	29.4%	38.5%	28.9%
White	30%	37.1%	28.1%	41.3%
Hispanic	20.4%	19.3%	21.2%	15.4%
Black	12.9%	14.2%	12.2%	14.3%
Gender				
Female	49.4%	49.7%	49.2%	51.8%
Average Attendance Rate	94.4%	94.4%	94.7%	94.8%
Average Time in District	3.42	3.52	3.48	3.59
CTB Reading	655 (2911)	655.2		
CTB Math	652 (2908)	647		
State English Language Arts			663 (1573)	669
State Math			660 (1579)	661

Note: The CTB exams are only administered to 3rd and 5th grade students, and the State tests only to 4th grade students. The values in parentheses in the table are the number of students who sat for the tests and who were not in the sample.

Comparisons of student data from sampled and non-sampled classrooms suggests that the achievement of students in these two groups is similar, as is the percentage of Black and Hispanic students and the average number of years students have spent in the district. (See table 3) However, the percentage of students eligible for free and reduced lunch is smaller and the percent of White students is somewhat higher in the sampled group than in other District #2 classrooms. Another difference is in the average percent of students with limited proficiency in English, with classrooms in our sample having fewer such students on average.

We have relatively little information on teachers who did not turn in surveys, making it difficult to describe precisely how these two groups of teachers may differ. However, of the 82 teachers who returned questionnaires and taught in grades 3-5, most are relatively new and young teachers. About half are under the age of 32 and 50% have been teaching for four years or less. In contrast, just about 19% have been teaching for 15 years or more. Moreover, many are fairly new to District #2, with 52% having taught in the district for three years or less and only about 18% having taught in the district for 10 years or more. Most of the responding teachers are White (72.2%), but a number were Asian (17.7%) and a few are Hispanic (2.5%) or Black (5.1%). Most are female (91.5%) and have master's degrees (92.6%).

Data analysis

In order to answer the first research question—How is District #2's improvement strategy being implemented?—we computed correlations to examine the extent to which key components of the district's improvement plan are related to one another. Research question two—What effect do the various components of the district's improvement plan have on student achievement?—is addressed in two parts. First we provide descriptive statistics in order to give an overview of achievement in District #2. Then hierarchical linear models (HLM) (Bryk & Raudenbush, 1992) are used to explore the extent to which measures of instructional leadership, professional community, professional development and classroom instruction captured at various levels of the school system influence student achievement in literacy and mathematics. Student-level data in these models includes information on student achievement and demographic characteristics such as ethnicity, English language proficiency and eligibility for free and reduced lunch. Classroom-level data includes teachers' questionnaire responses on their own experiences and ratings of classroom instruction provided by principals.

Data issues

Before continuing, we acknowledge difficulties with four key data issues. Each of them speak to the importance of careful interpretation of our findings.

The first involves the use of self-report measures like the teacher and principal questionnaires. These instruments often have important limitations that can compromise the validity of the information provided by respondents (Babbie, 1992; Stein & Henningsen, 1992). Self-report measures may promote socially desirable responses. For example, principals may not feel comfortable assigning poor ratings to their teachers. Another possible limitation is that respondents must accurately recall and/or judge their perceptions of events stretching over a period of time. For example, teachers were asked to characterize the quality and focus of their professional development experiences during the 1999-2000 school year, which may have varied greatly throughout that 8-month period. Creating a single characterization of those experiences may have been difficult for some teachers.

A second area of concern are self-selection effects. Data from the teacher and principal surveys may also contain skews because of self-selection effects. We have some capacity for ascertaining the representativeness of the principals data received through other data sources, such as school ratings and descriptions provided by District #2 leaders (D'Amico, van den Heuvel & Harwell 2000). However, we have no such means for the teacher data. The teacher survey sample, although fairly representative with respect to students (i.e., the students taught by the teachers in the sample were reasonably similar to students district-wide), may not have been representative with respect to teachers. With only 26% of the possible teachers represented, we cannot be sure that the sample was not perhaps somehow skewed with respect to potentially important variables such as number of years of teaching experience within the district or their general attitude toward their principals, the district and its programs. Such skews would have an effect on our measures of District #2's improvement strategy implementation and therefore limit our ability to interpret its effects on student achievement.

A third data issue is the effect of missing data on our inferences. In some cases, the amount of missing data was modest, but for other analyses the effect of missing data was substantial and it emanated from several sources. Some students are missing information about who their teacher is, or information on various characteristics (such as ethnicity or eligibility for free and reduced priced lunch), which drop them from consideration in the analyses. Of greater concern was that some teachers neglected to complete particular items on the questionnaire. The concern is that missing cases/scores for the reasons described may substantially bias the results in ways that

significantly impact our inferences. As described later, we imputed missing values for teacher's responses on the questionnaire, resulting in complete data for a subset of the questionnaire responses. (See Appendix B.) This does not eliminate the possibility of biased inferences, but, under some general assumptions about why teacher data were missing, decreases the likelihood of biased inferences. Missing student data was not imputed.

Finally, in some classrooms and schools, there was no variation for some student demographic variables such as ethnicity or eligibility for free and reduced price lunch, which drops those schools or classrooms from some of the HLM models. This raises the possibility that some of the HLM findings are biased by the absence of these classrooms. This issue is discussed in more detail in Appendix B.

IMPLEMENTATION OF DISTRICT #2'S IMPROVEMENT STRATEGY

Given the basic assumptions underlying District #2's improvement strategy — that strong school communities headed by competent instructional leadership will lead to quality professional development experiences for teachers that in turn will lead to strong instruction — we would expect to see significant correlations among these key components. Moreover, given the district's allegiance to common instructional frameworks, we might expect to see high alignment in both professional development and classroom instruction significantly correlated with classrooms that are judged to be of high quality.

Using classroom data, we explore these possibilities by reviewing the relationships between and among all of the components of the District #2 model for educational improvement as explicated in Figure 1. Figures 2 and 3 show that a number of these correlations were statistically significant.

In literacy, **the quality of professional development** appears to be a pivotal component around which many of the other components of the district's improvement strategy congeal. As shown in Figure 2, the quality of professional development was significantly related to five components of the District #2 model. At the school level, high-quality professional development was associated with teachers who judged their principals to be highly capable instructional leaders and who judged their buildings to be characterized by strong professional communities. At the classroom level, high-quality professional development was associated with classrooms in which instructional practices were judged to be of high quality and highly aligned with the district's Balanced Literacy framework. As such, professional development is an important component that ties the classroom components to the rest of the model.

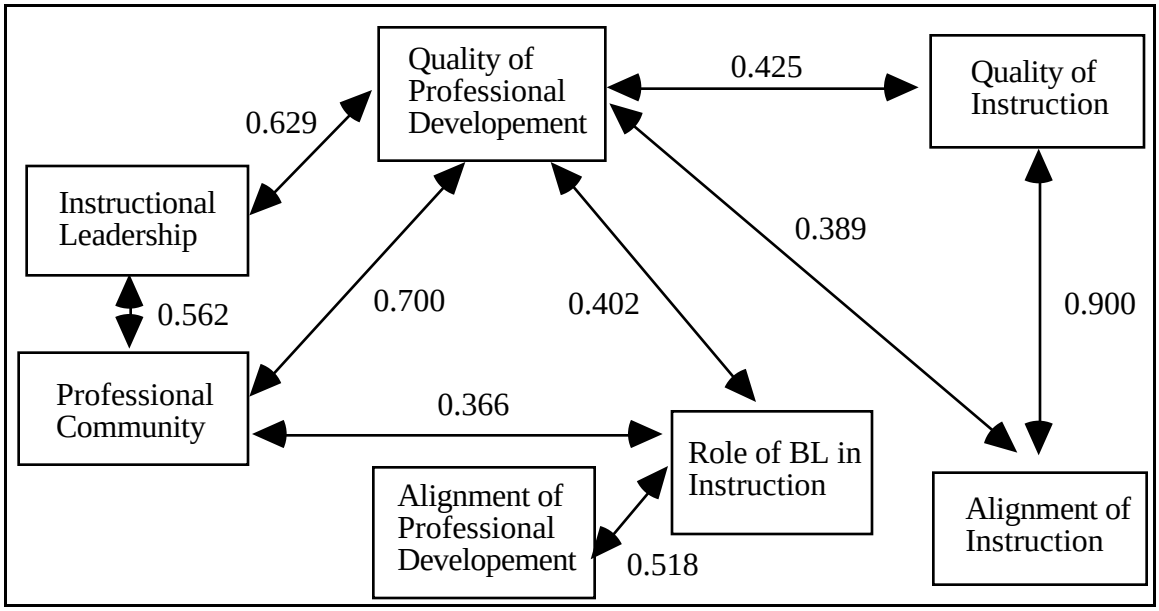

Figure 2: Significant correlations between components of District #2's improvement strategy in literacy (All correlations are significant at the 0.01 level, two-tailed.)

Instructional leadership—a key component of the district's strategy—appears to be more strongly tied to the strength of the school professional community and the quality of professional development than to other components of the model. (See Figure 2.) Teachers who gave their principals high ratings for their instructional leadership in literacy were more likely to judge the professional community in their school as strong (r = 0.562) and the quality of professional development in literacy during the last year as high (r = 0.629).

Finally, **alignment to the district's literacy framework** was found to relate to other components of the improvement strategy in both predictable and unpredictable ways. In terms of principals' judgments of individual teachers' instructional practice, it appears that high alignment is nearly synonymous with high quality. The principals' ratings for the quality and alignment of instruction in their teachers' classrooms were highly correlated (r = 0.900).

Another way to investigate the relationship between alignment and other components of District #2's improvement strategy is to examine the correlations between teachers' feelings about the pervasiveness of the Balanced Literacy program in their day-to-day professional lives (see Role of Balanced Literacy in Figure 2) and other components of the model. Interestingly, after Quality of Professional Development, this variable was the next most-connected variable in the model. Specifically, teachers who felt that the Balanced Literacy program played a strong role in their practice were more likely to judge their school professional community as strong (r =

0.366), and the quality of their professional development as high (r=.402) than were teachers who did not feel that the Balanced Literacy program played a strong role in their professional lives. Teachers were also more likely to judge the ties of professional development to Balanced Literacy as strong when they indicated that the Balanced Literacy program played a strong role in their instructional activities (r = 0.518).

Strangely, however, neither teachers' ratings of the role that Balanced Literacy plays in their work nor the alignment of professional development with the program were correlated with their principals' judgments on the alignment of their instruction with Balanced Literacy.

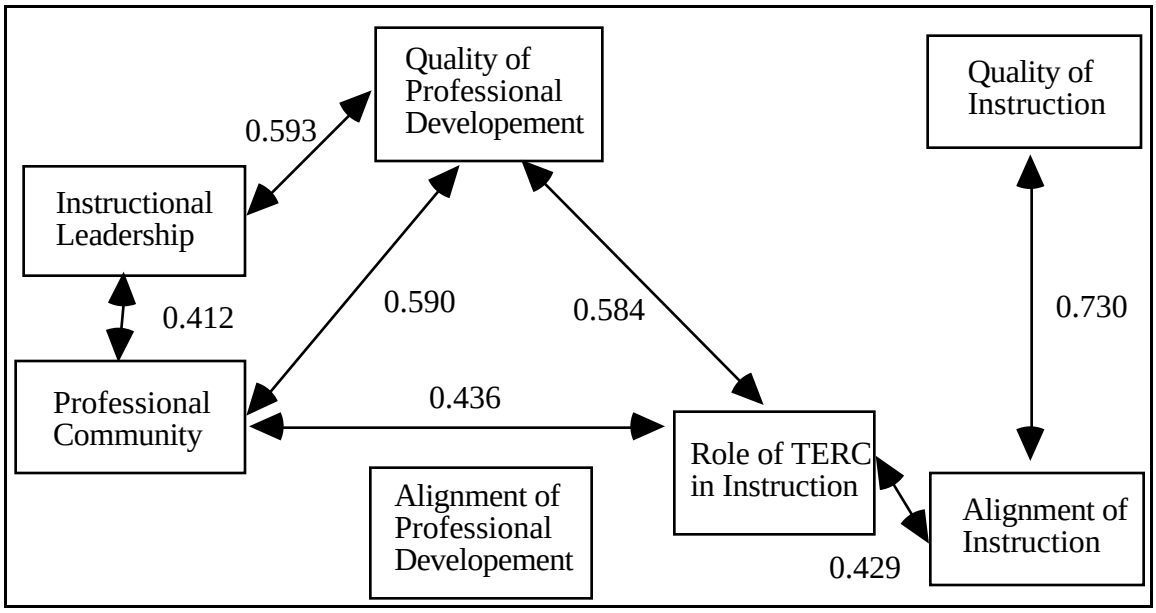

Figure 3: Significant correlations between components of District #2's improvement strategy in mathematics (All correlations are significant at the 0.01 level, two-tailed.)

In mathematics, **professional development** was again the most-connected construct. It was found to be significantly correlated with three other components. Teachers who indicated that the quality of their professional development in mathematics was high were also more likely to state that their principals provided strong instructional leadership in mathematics (r = 0.593) and that the professional community in their school was a strong one (r = 0.412). Moreover, teachers were more likely to judge the quality of their mathematics professional development to be high if they also indicated that TERC's *Investigations* curriculum played a strong role in their work (r = 0.584). However, unlike in literacy, teachers' judgments of the quality of their professional development in mathematics was not found to correlate significantly to the quality and alignment

of classroom instruction and hence did not play the same role of tying the classroom components to the school level components as the quality of professional development did in literacy.

Similar to the findings in literacy, **instructional leadership** in mathematics appears to be more strongly tied to the strength of the school professional community and the quality of professional development than to other components of the model (see Figure 3). Teachers who gave their principals high ratings for their instructional leadership in literacy were more likely to judge the professional community in their school as strong ($r = 0.412$) and the quality of professional development in mathematics during the last year as high ($r = 0.593$).

Finally, also similar to the findings in literacy, **alignment to the district's mathematics framework (the TERC curriculum)** was found to relate to other components of the improvement strategy in both predictable and unpredictable ways. Once again, principals' judgments of individual teachers' instructional practice consisted of significantly correlated ratings for quality and alignment ($r = 0.730$). Although not as high a correlation as for literacy, the significance of the relationship suggests, once again, that principals tend to judge high quality instruction and high alignment as closely related.

Similar to what was found about the Role of Balanced Literacy, teachers' feelings about the pervasiveness of the TERC curriculum in their day-to-day professional lives (see Role of TERC in Figure 3) was the next most-connected variable in the model. It was found to be significantly related to teachers' judgments about their school professional community ($r = 0.366$), and about the quality of their professional development ($r = 0.402$). In the case of mathematics, however, teachers' ratings of the role that TERC plays in their work *was* correlated with their principals' judgments of the alignment of their instruction with the TERC curriculum. On the other hand, prevalence of TERC did not correlate with judgments of how connected their professional development was to TERC.

In summary, the data described in this section provide some evidence of the implementation of District #2's overall improvement strategy during the 1999-00 school year. The strongest support is for the relationship between high-quality professional development, good instructional leadership and strong professional community. For literacy, high quality professional development also appeared to be associated with high quality instruction, as well as instruction that was closely aligned with the Balance Literacy program. Professional development did not appear to be associated with either high quality instruction or instruction closely aligned with the *Investigations* curriculum. However, this may be due to the relative newness of the mathematics initiative.

Overall, instructional leadership was not as robust a variable as one might have expected. For both mathematics and literacy it appears to be most closely related to judgments of professional community and quality of professional development. Interestingly, teachers' judgments of the quality of instructional leadership do not appear to be related, in either literacy or mathematics, to how aligned they perceived their professional development to be to the district's frameworks. Notably, instructional leadership was *not* correlated with high quality instruction in either literacy or mathematics.

Given the importance of district-wide instructional frameworks to District #2's overall strategy for educational improvement, it is interesting that alignment played out in a rather equivocal manner. One curious finding was the lack of a significant relationship between principals' ratings of degree of alignment of teachers' practice with the Balanced Literacy framework and teachers' own reporting of how pervasive Balanced Literacy program was in their professional lives. In mathematics, on the other hand, these two measures were significantly correlated. Together, these two findings may suggest that principals are better able to judge teachers' practice in literacy than in mathematics, not an unexpected finding given the newness of the mathematics initiative. Also curious was the lack of significant correlation between alignment of professional development in mathematics and anything else, particularly in contrast to literacy, in which alignment of professional development was associated with teachers' own judgment of how important Balanced Literacy was to their professional lives.

Many of the differences between the mathematics and literacy findings may point to the newness of the mathematics initiative as compared to the literacy initiative. In mathematics, the various components and their interrelationships do not appear to be as congealed as they are in literacy.

EFFECTS OF DISTRICT #2'S IMPROVEMENT STRATEGY ON STUDENT ACHIEVEMENT

Demonstrating the effectiveness of District #2's improvement strategy on student achievement is difficult. Given the district's high variability in ethnic diversity, poverty levels, and English proficiency, it is reasonable to expect that these factors will be strong predictors of academic achievement, leaving less variance to be explained by the programs of District #2. In order to detect increases in student performance it is reasonable to assume that program effects must be strong.

In this section, the effects of District #2's improvement strategy on student achievement are examined through the use of descriptive statistics and HLM analyses. We report on the

relationship between student achievement in both literacy and mathematics and student characteristics, including ethnicity, socio-economic status, English proficiency, gender, attendance, and number of years the student has been attending school in District #2. We also examine the relationship of student achievement to various aspects of District #2's improvement strategy.

Student achievement throughout District #2

The 4666 third and fifth grade students in District #2 are subject to the same kinds of achievement patterns seen in other school districts. Impoverished students (i.e. those eligible for free or reduced price lunch) tend to score lower than their more affluent classmates, by 28 points on the CTB reading test (standardized effect size (ES) = 0.84 standard deviations) and 24 points on the CTB mathematics test (ES = 0.47). Minority students, particularly Black and Hispanic students, also tend to have lower scores in both reading (mean = 643 for Black students; mean = 638 for Hispanic students) and mathematics (mean = 625 for Hispanic students; mean = 624 for Black students) than their White counter parts (reading mean = 672; mathematics mean = 664; ES = 1 between White and Hispanic students in reading; ES = 0.81 between White and Black students in mathematics). Finally, students who are proficient in English tend to perform better than those who are not proficient for both reading (ES = 1.24) and mathematics (ES = 0.74) by approximately 44 points and 38 points, respectively.[5]

Similar patterns emerged for the approximately 2200 fourth grade students who sat for the state-mandated tests in English Language Arts (ELA) and mathematics. Once again, impoverished students tend to score lower than their more affluent classmates, by 32 points on the state test in English language arts (standardized effect size (ES) = 0.83 standard deviations) and 21 points on the state mathematics test (ES = 0.56). Minority students tended to have lower scores in both English language arts (mean = 645 for Black students; mean = 646 for Hispanic students) and mathematics (mean = 636 for Hispanic students; mean = 635 for Black students) than their White counterparts (reading mean = 685; mathematics mean = 674; ES = 1.07 between White and Hispanic students in reading; ES = 1.12 between White and Black students in mathematics). Finally, students who are proficient in English tended to perform better than those who were not

[5] There was a large disparity in sample size between those who were proficient (N = 4110) and those who were not proficient (N = 116). In part, the small number of students tested who were not proficient in English (at least in reading) is attributable to the fact that a number of them are officially considered "exempt" from testing in English due to their limited proficiency.

proficient for both English language arts (ES = 1.45) and mathematics (ES = 1.06) by approximately 55 points and 54 points, respectively.[6]

In summary, the pattern of strong relationships between student achievement and background characteristics (ethnicity, socio-economic status, and English language proficiency) that is so prevalent in other studies of urban student achievement is also evident in District #2.

Modeling the relationship between student characteristics, components of District #2's improvement strategy and student achievement

The HLM analyses take into account the relationships between socio-economic status, gender, ethnicity, English proficiency, attendance and District #2 enrollment both within and between individual classrooms. They also explore the effect of District #2's improvement strategy on achievement and the relationship between achievement and student characteristics.

Student achievement and its relationship to student characteristics

We explore the relationship between student characteristics and academic achievement in three ways. First, we describe the extent to which classroom aggregates of student characteristics (e.g. the percent of students within a given classroom eligible for free or reduced price lunch) can predict mean academic achievement of students within that classroom. Second, we look at the the ability of individual student characteristics (i.e. is a particular student eligible for free or reduced price lunch) to predict individual academic achievement within each classroom. Finally, we look at the extent to which the relationship between individual student characteristics and achievement vary by classroom.

As Table 4 demonstrates, the classroom composition with respect to socio-economic status, English proficiency and attendance were all weak predict predictors of student achievement in literacy as measured by both the CTB in reading and the state exam in English language arts. In other words, those classrooms with fewer students eligible for free and reduced price lunch, higher average attendance rates, and higher percentages of students who were proficient in English, tended to have higher mean achievement in literacy. Fewer classroom aggregates of student characteristics were predictive of mean achievement in mathematics. While average attendance was a moderate predictor of mean achievement as measured by both the CTB and the state exams in mathematics, socio-economic status was only a weak predictor and just for the CTB scores. Both both subjects, as measured by both exams, a considerable amount of variation

[6] Once again, there was a large disparity in sample size between those who were proficient in English (N = 2112) and those who were not proficient (N = 77).

in the mean student achievement among classrooms was still unexplained when just these aggregates of student characteristics were included in the model.

Table 4: Predictive power of classroom aggregates of student characteristics on classroom mean achievement

	CTB		State Exam	
	Reading	Mathematics	Reading	Mathematics
Socio-economic status	**Weak**	**Weak**	**Weak**	Not Sig
English proficiency	**Weak**	Not Sig	**Weak**	Not Sig
Ethnicity	Not Sig	Not Sig	Not Sig	Not Sig
Attendance	**Weak**	**Moderate**	**Weak**	**Weak-moderate**
Gender	Not Sig	Not Sig	Not Sig	Not Sig
Time in District	Not modeled	Not modeled	Not Modeled	Not Modeled

Rough estimate of effects provided for statistically significant ($p < 0.05$) results only.

When the relationship between individual student characteristics and individual student achievement was examined within classrooms, socio-economic status, attendance and ethnicity were found to be statistically significant predictors of student achievement as measured by the CTB in both literacy and mathematics. In mathematics, gender was also a predictor of student achievement. Achievement as measured by the state test (in both English Language Arts and mathematics) was predicted by ethnicity, attendance and the number of years the student had been enrolled in District #2. Moreover, socio-economic status and gender were both predictors of reading achievement as measured by the state test in English Language Arts. These findings appear in the first two columns of Tables 5 and 6.

These within-classroom relationships between student characteristics and student achievement were consistent across classrooms in most cases. However, the relationship between socio-economic status and achievement in both reading and mathematics as measured by the CTB varied significantly between classrooms. In other words, in some classrooms the tie between socio-economic status and achievement was stronger than in others. Similarly, the relationship between ethnicity and student achievement in both reading and mathematics as measured by the CTB varied significantly between classrooms. These findings can be seen in the final two columns of Tables 5 and 6.

Table 5: Summary of HLM results relating student achievement to student characteristics for CTB

	Predictive power of student characteristics on individual student achievement		Variation in the relationship between student characteristics and student achievement by classroom	
	Reading	Mathematics	Reading	Mathematics
Socio-economic status	**Strong**	**Strong**	**Sig**	**Sig**
Ethnicity	**Moderate**	**Moderate**	**Sig**	**Sig***
Attendance	**Weak**	**Weak**	Not Sig	Not Sig
Gender	Not Sig	**Weak-Moderate**	Not Sig	Not Sig
Time in District	Not Sig	Not Sig	Not Sig	Not Sig

Rough estimate of effects provided for statistically significant ($p < 0.05$) results only.
*This variable was so close to being significant ($p = 0.056$) that it was treated it as significant.

Table 6: Summary of HLM results relating student achievement to student characteristics for state-mandated tests

	Predictive power of student characteristics on individual student achievement		Variation in the relationship between student characteristics and student achievement by classroom	
	Reading	Mathematics	Reading	Mathematics
Socio-economic status	**Strong**	Not Sig	Not Sig	Not Sig
English proficiency	Not modeled	Not modeled	Not modeled	Not modeled
Ethnicity	**Strong**	**Strong**	Not Sig	Not Sig
Attendance	**Weak**	**Weak**	Not Sig	Not Sig
Gender	**Strong**	Not Sig	Not Sig	Not Sig
Time in District	**Weak**	**Weak-Moderate**		Not Sig

Rough estimate of effects provided for statistically significant ($p < 0.05$) results only.

Next we explore to what extent the variation between classrooms in these relationships between socio-economic status and achievement and ethnicity and achievement can be explained by classroom differences in the implementation of District #2's improvement strategy.

Effect of various components of the District #2 model on student achievement

We next explore the extent to which two types of variation—(a) overall variation in mean student achievement between classrooms; and (b) the variation between classrooms in the relationship between student characteristics and student achievement—can be attributed to various components of District #2's improvement strategy. The intersection between teacher survey data, principals' ratings of teachers' instruction and fourth grade students who took the state exams created too small a sample of classrooms to effectively run HLM models. As a result, our analyses of the effects of components of District #2's improvement strategy on student achievement use only CTB data. There were 34 classrooms for whom we have CTB data in reading and mathematics, as well as teacher questionnaire data and principal ratings of instruction.

There was considerable variation among mean classroom achievement in both literacy (40% for the CTB) and mathematics (55% for the CTB) which was attributable to between classroom variation. It is possible that classroom composition and/or effects of District #2's improvement strategy might account for at least part of the variation among classrooms. Findings indicate that two of the components of District #2's improvement strategy predict achievement in either subject. As shown in Table 7, teachers' judgments of the quality of their mathematics professional development was a moderate predictor of mean classroom performance on the CTB in mathematics. Alignment of instruction with Balanced Literacy was a strong predictor of mean classroom performance on the CTB in reading.

Close inspection of Table 7 also shows that, for literacy, socioeconomic status, English proficiency, and attendance[7] remain significant predictors of mean student achievement per classroom even when additional predictors (the district's improvement components) are available. In mathematics, none of the aggregates of student characteristics (weak predictors initially as shown in Table 4) remain significant once the District #2 improvement strategies are included in the HLM analyses.

[7] Socio-econoomic status, attendence and ethnicity were found to be significant at the individual level for the CTB (see Table 4)

Table 6: Summary of HLM results of the predictive power of components of District #2 model on classroom mean achievement as measured by the CTB

	Reading	Mathematics
School professional community	Not Sig	Not Sig
Quality of instructional leadership	Not Sig	Not Sig
Quality of professional development	Not Sig	**Moderate**
Alignment of professional development with BL/TERC	Not Sig	Not Sig
Quality of instruction	Not Sig	Not Sig
Alignment of instruction with BL/TERC	**Strong**	Not Sig
Role of BL/TERC in teachers' work	Not Sig	Not Sig
Classroom aggregates of student characteristics	**Weak**	Not Sig
Socio-economic status	**Weak**	Not Sig
English proficiency	Not Sig	Not Sig
Ethnicity	Not Sig	Not Sig
Gender	**Weak-moderate**	Not Sig
Attendance		

Rough estimate of effects provided for statistically significant ($p < 0.05$) results only.

These findings suggest that teachers who align their practices with the Balanced Literacy program (as reported by their principal) reap the benefit of significantly higher student achievement than do teachers whose practices were not judged to be aligned with the Balanced Literacy program. Nevertheless, socio-economic status continues to play a significant role in reducing students' achievement in literacy, although its effect at the classroom level was weaker and may be the result of the district's improvement strategies (the predictive power of socio-economic status on student achievement went from strong [Table 4] to weak [Table 6]). In mathematics, it is the quality of professional development that is the strongest predictor of student achievement at the classroom level.

Next, we examine the extent to which components of District #2's improvement strategy account for variation in the classroom relationships between achievement and two demographic characteristics—socio-economic status and ethnicity. As shown in Table 8, the findings indicate

that teachers who report that Balanced Literacy plays a strong role in their work were less likely to be in classrooms where the link between socio-economic status and achievement is a strong one. Likewise, teachers who indicted that the *Investigations* curriculum played a strong role in their work were less likely to be in classrooms where the link between socio-economic status and mathematics achievement is strong. These were both moderate effects and suggest that the support provided to teachers through the use of Balanced Literacy and the *Investigations* curriculum may help reduce the link often seen between socio-economic status and student achievement.

Table 8: Summary of HLM results of the predictive power of components of District #2 model on classroom differences in the relationship between student characteristics and student achievement (as measured by the CTB)

	SES		Ethnicity	
	Reading	Mathematics	Reading	Mathematics
School professional community	↑ **Moderate**	↑ **Weak-Moderate**	Not Sig	Not Sig
Quality of instructional leadership	Not Sig	Not Sig	Not Sig	Not Sig
Quality of professional development	Not Sig	Not Sig	Not Sig	Not Sig
Alignment of professional development with BL/TERC	Not Sig	Not Sig	Not Sig	↑ **Moderate**
Quality of instruction	Not Sig	↑ **Moderate**	Not Sig	Not Sig
Alignment of instruction with BL/TERC	Not Sig	Not Sig	Not Sig	Not Sig
Role of BL/TERC in teachers' work	↓ **Moderate**	↓ **Weak-Moderate**	Not Sig	Not Sig

Rough estimate of effects provided for statistically significant ($p < 0.05$) results only.
↓ means that the within-classroom relationship is weakened by higher values of the classroom predictor;
↑ means that the within-classroom relationship is strengthened by higher values of the classroom predictor.

However, not all the effects of District #2's improvement strategy appear to be such beneficial ones. For example, teachers who judged the professional communities in their schools to be strong ones were *more* likely to be in classrooms where the relationship between socio-economic status and achievement was strong. This moderate effect held for both literacy and mathematics achievement and suggests that highly cohesive, professional school communities are associated with stronger links between students' socio-economic status and their achievement.

The other effects that are different than what would have been predicted all fall within mathematics: (a) The relationship between mathematics achievement and socio-economic status was moderately stronger in classrooms where principals gave teachers high ratings for the quality of their instruction; (b) The relationship between mathematics achievement and ethnicity was moderately stronger in classrooms in which teachers indicated that much of their professional development in mathematics was tied to the *Investigations* curriculum. These findings may indicate that the curriculum District #2 has adopted in mathematics is better suited to white middle class children than it is to impoverished and ethnically diverse children. More likely, it indicates that the teachers themselves have not been working with the curriculum long enough to develop skill at adapting it for the wide range of students in their classrooms. On the other hand, the findings may be a simple artifact of the teachers and principals themselves as judges of the curriculum. Because of the newness of the Mathematics Initiative, principals may not be as keen judges of the quality of the mathematics instruction as they are of the quality of literacy instruction. Similarly, teachers may not be as good a judge of the alignment of their professional development with *Investigations* as they are regarding the alignment of their professional development with Balanced Literacy.

Overall, then, the findings of the HLM analyses (Tables 4-8) suggest different story lines for District #2's Literacy and. Mathematics Initiatives. In literacy, the findings are more understandable and congruent. Basically, the findings suggest that the alignment of instructional practice to the Balanced Literacy program is associated with improved student outcomes. This is evidenced by the strong predictive power of principals' judgements of alignment of instruction on mean classroom student achievement and by the finding that the link between students' socio-economic status and their achievement is significantly weakened in those cases in which teachers report that Balanced Literacy plays an important role in their day-to-day professional lives.

In mathematics, the findings are more difficult to interpret. In particular, no clear story line emerges for either professional development or instructional practice. While quality of professional development proves to be a predictor of student achievement, high alignment of professional development with TERC's *Investigations* curriculum is actually associated with stronger links between students' ethnicity and their achievement. And while teachers' report of high importance of TERC to their day-to-day professional lives was found to result in weakened links between students' socio-economic status and their achievement, high quality of instruction (as judged by their principals) was actually found to strengthen the links between socio-economic status and achievement.

DISCUSSION

New York City's Community School District #2 has in recent years enjoyed a national reputation for the strength of their strategy for instructional improvement, particularly the quality of their professional development system and the strength of their instructional leadership. Rough measures of achievement indicated that this strategy was a successful one. For example, between 1988 and 1998, the percent of students achieving at or above grade level rose from 56% to 73% in reading and 66% to 82% in mathematics (HPLC Technical Report, 2000). Moreover, previous research has also provided indications that the strategy was effective (e.g., Resnick & Harwell, 1998; Stein, Harwell & D'Amico, 1999), and the results of the current study bolster that argument.

The correlation analyses indicate that quality instructional leadership, strong professional communities and quality of professional development are correlated with one another in both literacy and mathematics. Moreover, both the quality of literacy instruction and its alignment with District #2's Balanced Literacy program are correlated with the quality of the professional development teachers experience. These findings provide some evidence supporting the district leadership's belief that improvements in instruction can be produced through strong instructional leadership on the part of principals who work closely with staff developers to create both a strong professional community in their school and high quality professional development experiences for their teachers. It is possible that as the younger Mathematics Initiative matures in District #2, a similar link between professional development and instruction will develop.

However, there is little evidence that strong instruction (as judged by District #2 principals) leads to better student achievement in either literacy or mathematics. Instead, other aspects of District #2's improvement strategy emerge as strong predictors of student achievement. In particular, working closely with the Balanced Literacy program and TERC's *Investigations* curriculum appears to reduce the likelihood that there will be a strong connection between achievement and socio-economic status in literacy and mathematics within a given classroom. In other words, teachers who use these programs appear to level the playing field between the impoverished and more affluent students in their classrooms. In addition, the mean reading achievement of students in classrooms where the instruction is closely aligned with Balanced Literacy is higher than that of students in classrooms where it is less aligned. And finally, the mean mathematics achievement of students in classrooms where teachers report having received strong professional development in mathematics is higher than that of students in classrooms where the teacher received professional development of lesser quality. These findings indicate that both the Balanced Literacy program and the *Investigations* curriculum in conjunction with

high quality professional development provide the support that teachers need to not only improve student learning overall, but to break down the barriers that impoverished students often face. They thus support District #2's conviction that professional development which is anchored by a core instructional program or curriculum can increase student learning.

The findings, however, are not perfectly in the alignment that one would predict if the District #2 model was performing flawlessly. Some pieces of District #2's improvement strategy failed to show a direct link to student achievement at all (e.g., quality of instructional leadership). Moreover, a few had puzzling negative effects (e.g. schools with strong professional communities appeared to more likely have classrooms in which the achievement gap between impoverished and affluent children was a large one).

There are issues with both the data and analysis that suggest caution be taken with these findings, both the encouraging and less than encouraging ones. We mentioned earlier that problems associated with missing data, lack of variation in some data, self-report and self-selection effects all indicate the need for careful interpretation of our findings. We discuss here in slightly more detail, some of our specific self-report concerns, as well as some limitations of the kinds of analyses used.

Interpretation of "quality" and "alignment"

The measures of each component of District #2's improvement effort are all based on judgments made by teachers and principals. The interpretation of findings based on these data depend on the extent to which we believe that the responding teachers and principals were capable of making the requested judgments and what effect the history of work in each subject matter initiative may have had on their understanding of the questions being asked. Certainly some teachers and principals are probably better judges of the quality of professional development, instruction and leadership than others and such differences may affect our results. However, of more concern are systematic effects on the respondents interpretation of the questions being asked.

In particular, we believe that the differences in the histories of the Literacy and Mathematics Initiatives may have implications for how both "quality" and "alignment" of professional development and instruction are interpreted by teachers and principals in District #2 (D'Amico, van den Heuvel & Harwell, 2000). The district's Literacy Initiative has been in place for over a decade. While based on models out of New Zealand and Australia, the Balanced Literacy program at its core has a "home grown" feel to many of District #2 educators. There is a wide

spread understanding of its basic structure and principles which permeate the entire district. Often teachers, principals and district leaders will speak of instruction as being aligned with Balanced Literacy if it meets the underlying principles of the program even if they do not meet the structural features of it (Stein & D'Amico, 2000a; Stein, D'Amico & Israel, 1999).

In contrast, the Mathematics Initiative is just five years old and only in its second year of district-wide expansion. Moreover, in the early years of this newer initiative, schools were not encouraged to focus on mathematics until the district leadership felt their literacy instruction was fairly strong. Thus, the curriculum at its core is not as well known throughout the entire district as is the Balanced Literacy program. Moreover, while already some of the teachers and principals at the vanguard of the initiative are working on changes and adaptations they feel need to be made to the curriculum, for most it is being adopted whole cloth, as is (Stein & D'Amico, 2000b; Hudson, 2000).

As a result of these differences, we believe District #2 educators may be more likely to focus on alignment of pedagogical principles with respect to Balanced Literacy and alignment with surface features of the curriculum with respect to *Investigations.* Moreover, we think it likely that both teachers and principals will tend to be better judges of quality professional development and instruction in literacy than in mathematics.

Optimistic principals

We are particularly concerned about the principals' responses to our questionnaire. Overall, their responses were overwhelmingly positive for all items measured (D'Amico, van den Heuvel & Harwell, 2000). Their strong positive ratings may be due to several factors. They may honestly believe that the professional development and instruction in their schools is as high in quality as their ratings show. If this is the case the district leadership may need to be concerned about their ability to spot struggling teachers when necessary. It is more likely, however, that the social complications of the situation may have made it difficult for the principals to answer honestly. Principals are likely to identify strongly with their schools and are proud of their work there. As a result, they may have felt uncomfortable providing low ratings that might then reflect back poorly on them. They may also care deeply about their teachers—even the struggling ones—and thus feel uncomfortable with providing hard criticisms of their work to strangers. In fact, of the five principals who did not provide us with ratings of the quality and alignment of their teachers' instruction, two either called or sent notes to explain they felt it was inappropriate for them to supply such information for anything other than official evaluations used by the school system.

While understandable, the overall positive pattern of their responses make it difficult for us to determine whether they were sufficiently critical when evaluating both the quality of instruction in teachers' classrooms and its alignment with District #2's programs. This uncertainty leads us to suggest caution when interpreting findings based on their judgments. We are currently in the process of coding write-ups of classroom observations conducted during the 1999-2000 school year in 49 third grade classrooms across 16 District #2 elementary schools. The teachers in 32 of these classrooms also completed questionnaires. Replacing the principals' ratings of instructional quality and alignment with District #2 programs with that of the researchers in our HLM analyses may help to resolve this issue.

Limitations of our analysis

The analysis tools used in this study do not enable us to look at the mediated effects of various components of District #2's improvement strategy on one another and on student achievement. Given the district's improvement strategy (see Figure 1), we expect that mediated effects may be an important contribution to the story. In other words, the district leaders do not expect the quality of instructional leadership to have a direct impact on student achievement. Instead, they expect instructional leadership to influence the quality of professional development provided to teachers and therefore the quality of teaching, which in turn will improve student achievement. Formal study of the role of mediated effects call for the use of path analysis models like those reported in Resnick and Harwell (1998). Attempts to fit similar models to the current data have so far been unsuccessful. However, we believe that the models we have used to date may be too simple and analysis of this kind deserves further exploration.

Finally, perhaps one of the biggest and most difficult problems to solve with the current analysis is our reliance on data collected completely within District #2 and for only one school year. In essence, we are not studying the overall effect of District #2's improvement strategy, but variations in its effectiveness within the district during one school year. We attempted to measure the strength of the implementation of various aspects of District #2's strategy to determine whether school and classroom level differences in their implementation effected student achievement during one school year. Such a design both ignores the possibility that some effects may only be seen longitudinally and does not take into consideration the possibility that the district as a whole may be in a different space than other urban districts. In other words, our analyses can only reveal shades of gray in the effectiveness of District #2's program in different schools and classrooms. It cannot tell us whether or not, overall, achievement in District #2 has been positively affected by their efforts. We have access to student test scores over a multi-year period, but no consistent data on the implementation of improvement strategy components

during that time. Moreover, we have no means of comparing District #2's strategy and student achievement to that of other urban districts. As a result, this particularly troubling concern is not one which will be easily resolved.

Conclusion

Despite these concerns and limitations, the findings described herein provide support for the viability of District #2's improvement strategy in literacy as shown in Figure 1 and as described in the introduction. In particular, high quality professional development appears to be associated with both high quality and highly aligned instructional practice—and when instructional practice is highly aligned to the principles of the Balanced Literacy framework it appears to significantly weaken the links between student achievement and their socio-economic status (a nontrivial accomplishment). While the findings are more equivocal in mathematics, with time, we might expect that District #2's two guiding principals—focus on instruction and the adoption of district-wide instructional frameworks—will prove to be similarly beneficial to student achievement in mathematics as well.

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APPENDIX A: SELECTED ITEMS FROM TEACHER QUESTIONNAIRE

Variables/Constructs

3. Education and Background

3a. What is the highest degree you have completed thus far?
3b. When did you complete this degree?
3c. When did you graduate high school?
3d. What is your ethnic background?
3e. What is your gender?

4. Teaching Experience

4a. How many years have you been teaching in a school that serves K-12 students?
4b. How many years have you been teaching in your current school district?
4c. How many years have you been teaching at your current school?

5. Your principal

5a. Ability to provide guidance and feedback on your literacy instruction
5b. Ability to provide guidance and feedback on your mathematics instruction
5c. Ability to communicate with teachers in your school

Quality of Instructional Leadership-Literacy

Quality of Instructional Leadership-Mathematics

6. The professional community at your school

6a. There is a common goal or vision about how to best help students learn.
6b. Teachers have a common language with which to discuss their work toward common goals.
6c. Teachers feel comfortable visiting one another's rooms and talking about instruction.
6d. Teachers often work together to plan instruction as well as design or review books, materials, curricula, etc.
6e. There is a commitment among the teachers to improve their teaching.
6f. I feel comfortable asking for help from other teachers.

Strength of School Professional Community

7. Professional development in literacy

B. Quality of professional development in literacy

7Ba. How students learn to read and/or write
7Bb. How to teach students to read and/or write
7Bc. How to asses students' proficiency in reading and/or writing

Quality of Professional Development in Literacy

7Bd. How to plan instruction based on students' assessed proficiency in reading and/or writing
7Be. How to write and/or to interact with literature as an adult learner

C. Role of the Balanced Literacy program

7Ca. How much of the Professional Development in literacy that you received in the last year was directly tied to the Balanced Literacy program?
7Cb. How familiar are you with the Balanced Literacy program?
7Cc. To what extent does the Balanced Literacy program provide support for you as you plan and carry out your lessons?
7Cd. How important is it to your principal that you incorporate Balanced Literacy into your instruction?

Alignment of Professional Development with Balanced Literacy

Role of Balanced Literacy in Teachers' Work

8. Professional Development in Mathematics

B. Quality of professional development in mathematics

8Ba. How students learn to understand and do mathematics
8Bb. How to teach students to understand and do mathematics
8Bc. How to assess students' proficiency in mathematics
8Bd. How to plan instruction based on students' assessed proficiency in mathematics
8Be. How to engage in mathematics as an adult learner

Quality of Professional Development in Mathematics

C. Role of TERC *Investigations* curriculum

8Ca. How much of the Professional Development in math you've received in the last year was directly tied to TERC's *Investigations* curriculum?
8Cb. How familiar are you with TERC's *Investigations* curriculum?
8Cc. To what extent does TERC's *Investigations* curriculum provide support for you as you plan and carry out your lessons?
8Cd. How important is it to your principal that you incorporate TERC's *Investigations* curriculum into your instruction?

Alignment of Professional Development with TERC's *Investigations*

Role of TERC's *Investigations* in Teachers' Work

APPENDIX B: DETAILED STATISTICAL ANALYSES

Reliability and Factor Analyses of Teacher Questionnaire Data

We investigated the reliability and validity of the various teacher subscales using Cronbach's alpha reliability coefficient and factor analysis (principals responses were not analyzed in this fashion because the sample was too small). The sample of teachers data that was analyzed was restricted to those teaching in grades 3-5, and unless otherwise noted, the reliability and factor analyses were based on a sample of 75-82 teachers, depending on the presence of missing data. The results of the reliability and factor analyses are summarized in Table 9.

The reliability of the literacy subscales was moderately high, with a median reliability across subscales of .77. The Perception of Principal subscale showed the lowest estimated reliability (.71). Factor analysis was used to examine the extent to which items for a literacy subscale appeared to "hang together," providing evidence of construct validity. The maximum likelihood factoring routine in SPSS was used to extract factors. The Role of Balanced Literacy subscale consisted of items 7cb-7cd in the teacher questionnaire; item 7ca (How much of the Professional Development in Literacy That You Received in the Last Year was Directly tied to the Balanced Literacy program?) was treated as a separate variable.

In every case, the proposed subscale structure was generally supported by the data in that a single factor (only one eignevalue exceeded a value of one) appeared for each subscale and factor loadings that tended to be quite similar in value. These results provide general evidence of construct validity because the hypothesized literacy subscale structures were supported by the data.

Table 9: Reliability and Factor Analysis Results for the Teachers Questionnaire Data

Subscale	Reliability	Range of Factor Loadings	
Prof. Comm. At Your School (6a-6f)	.91	.70 -- .89	
Qual. Of Prof. Dev. In Literacy (7ba-7be)	.92	.77 -- .94	
Role of Balanced Literacy Program (7cb-7cd)	.71	.69--.72	
New Standards Performance Standards in English Language Arts (7daNSPS-7dcNSPS)	.83	.64--.88	
New Standards Early Literacy Standards (7daNSELS-7dfNSELS)	.85 (63)	.73--.90	
Qual. Of Prof. Dev. in Math (8ba-8be)	.93	.74--.96	
Role of TERC (8cb-8cd)*	.61	.33--.98	
New Standards Performance Standards in Math (8daNSPS-8dcNSPS)	.91	.77--.97	
NCTM Standards (8daNCTM-8dcNCTM)	.90 (64)	.80--.98	

The mathematics subscales showed a similar pattern with the exception of the TERC subscale. The median reliability across mathematics subscales of the teacher questionnaire was .76. Factor-analytic results led to the decision to delete item 8cd of the TERC subscale (How Important is the Incorporation of TERC to Your Principal) because the associated loading was small/negative. Deletion of this item reduced the TERC subscale to three items but led to better reliability and higher and more consistent loadings. Subsequent data analyses involving TERC are based on three items (8ca-8cc).

After examining the factor-analytic results we computed factor scores for each subscale for each teacher. Correlations among factor scores for each subscale appear in tables 9 and 10 (factor scores have a mean of 0 and a standard deviation of 1). On the whole, the literacy and mathematics teacher subscales appear to be reliable and to show evidence of construct validity.

Descriptive analyses of student data

Relationships between Demographic Variables for all 3rd-5th Grade Students

SES x Ethnicity. Closer examination of the student demographic data reveals several interesting patterns, including SES and Ethnicity. As seen in Figure 4, sharp differences appear in the percentages of students in various ethnic groups in the high and low SES groups. There was a statistically significant relationship between these two variables ($p < .05$), with a moderate Cramer's statistic ($V^2 = .36$), meaning that approximately 34% of the variation in SES is a function of a student's ethnicity.

In examining the gaps between high and low SES groups, the percentage of Black students in the low SES group is slightly higher (14%) than that in the high SES group (11%). However, for Hispanic students this gap is much larger (26% and 12%, respectively). The widest gap exists for Whites, with these students making up 9% of the low SES group and 63% of the high SES group. Overall, the group with the largest low SES representation was Asian students (50%).

Figure 4

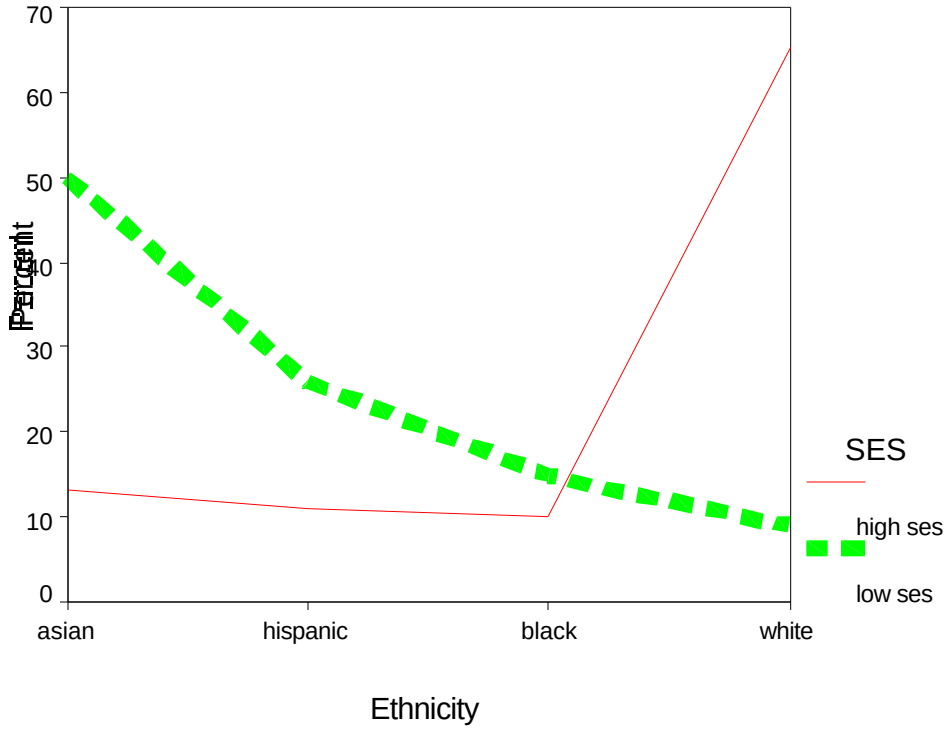


Figure 4: Ethnicity and socio-economic status of district #2 students

LEP x Ethnicity. The pattern for LEP and Ethnicity was similar to that involving SES but weaker. Although there was a statistically significant relationship between these two variables ($p < .05$), the V^2 statistic of .06 means that relatively little of the variation in LEP status depends on Ethnicity. This is borne out by Figure 5. White and Black students show the highest levels of proficiency, followed by Hispanic and Asian students. The latter group shows the highest levels of students classified as LEP—almost 66% of students classified as not proficient in English are Asian.

Figure 5

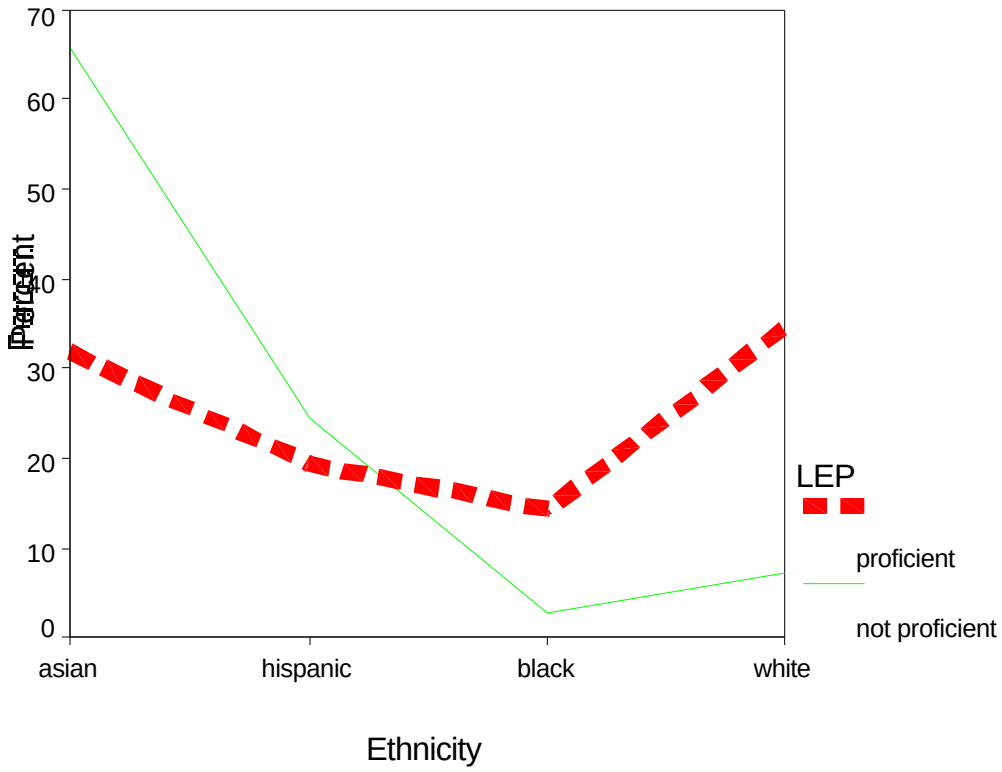


Figure 5: Ethnicity and English proficiency of District #2 students

SES x LEP. Although there is a statistically significant relationship between SES and LEP ($p < .05$), it is weak-positive ($r = .20$), meaning that students who were classified as LEP were somewhat likely to be in the low SES group. This is confirmed in Figure 6, which shows that most LEP students (90%) were in the low SES group.

Figure 6

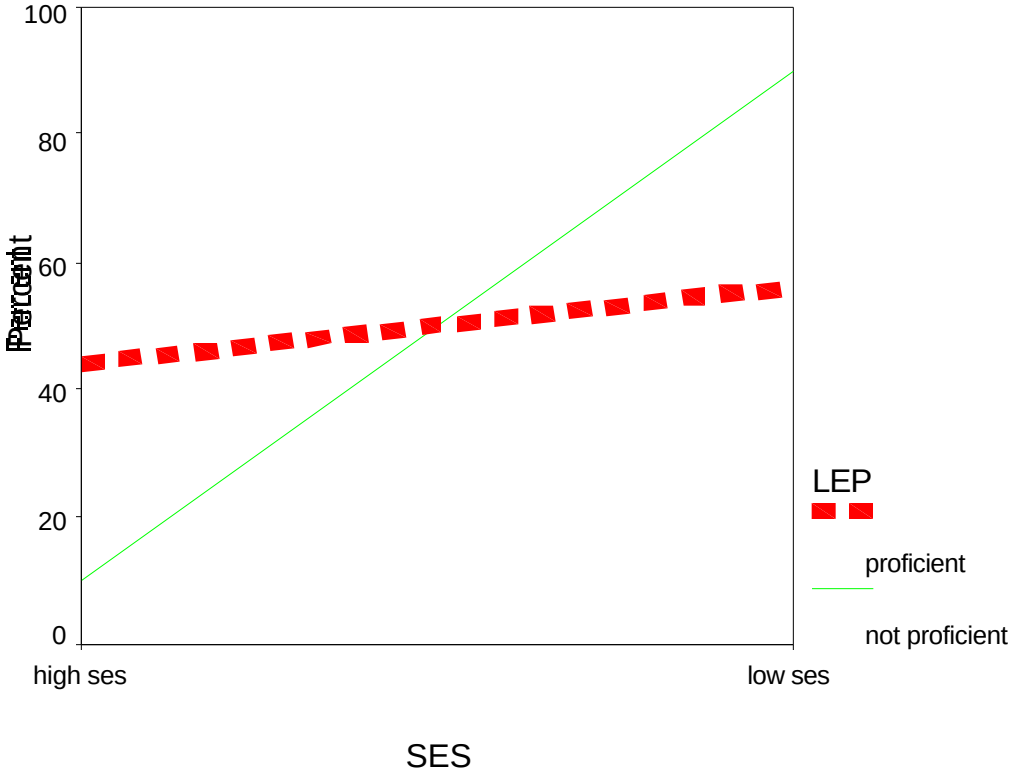


Figure 6: Socio-economic status and English proficiency of District #2 students

Attendance. The attendance results indicate that the average attendance rate for 3rd-5th grade students was 94.5%, although, as expected, this variable's distribution is strongly negatively-skewed. There were dramatic differences among the various ethnic groups in average attendance rates. Asian students had the highest average attendance rate (97.6%), followed by White (93.8%), Black (91.9%), and Hispanic (91.7%) students. Across all District #2, students in the high SES group and those proficient in English showed slightly higher attendance rates. However, when restricted to grades 3-5, low SES students actually had slightly higher attendance rates (93.5% vs 94%, respectively. The same pattern emerged for those proficient and not proficient in English (93.7% vs 94%). These differences amount to less than one day per school year.

Reading and Mathematics Achievement

Descriptive statistics for the student reading, mathematics, and attendance variables are presented in table 15. The average score for reading was slightly higher than in mathematics, and the data for these variables were reasonably close to a normal distribution. Breaking these variables down by the student demographic variables allows a more detailed picture of District #2 students to emerge.

Ethnicity. As seen in Figure 7, the performance of the Ethnicity groups is higher in reading than in mathematics, with White students outperforming the other groups. A similar pattern emerged for the state-mandated ELA and mathematics tests and these results are not shown.

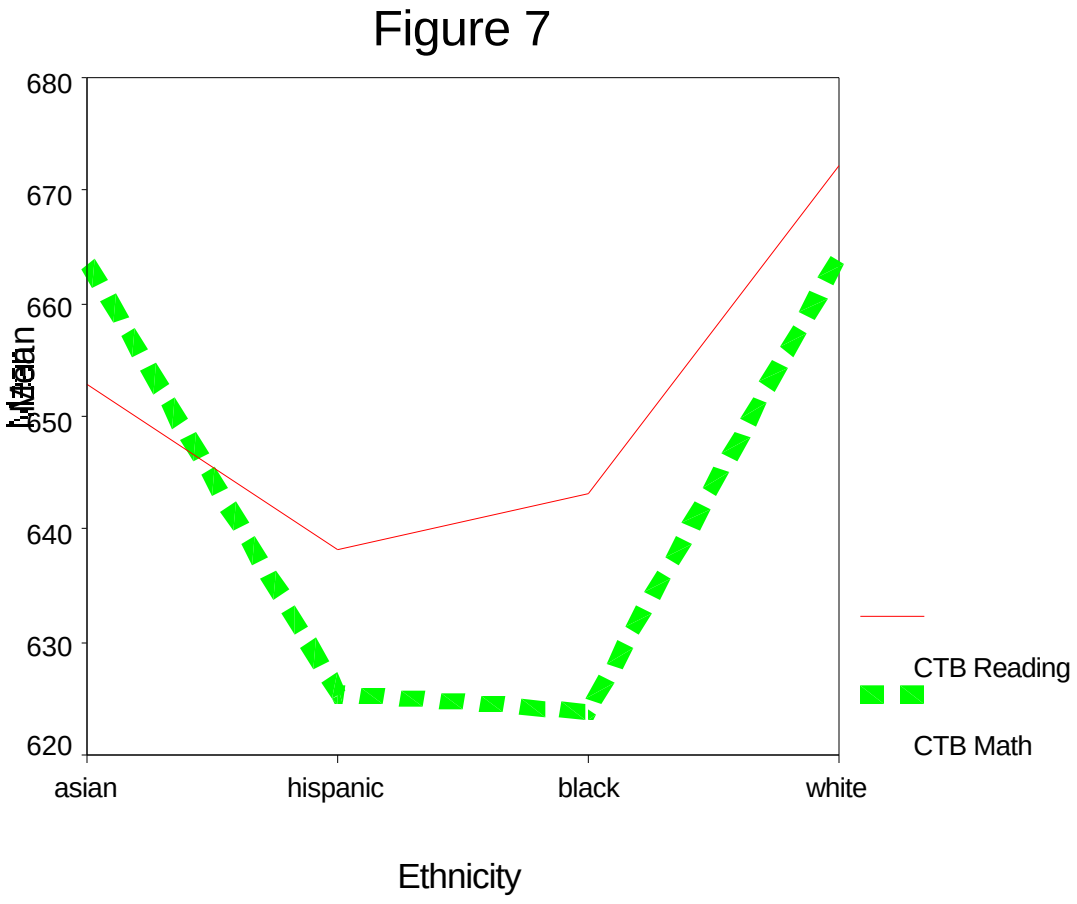


Figure 7: Ethnicity and District #2 student achievement on the CTB in reading and mathematics

SES. As seen in Figure 8, the pattern of reading and mathematics performances are reasonably similar across both levels of SES, with both groups scoring higher in reading than in mathematics. For reading, there was a 28-point difference between the low and high SES groups (effect size (ES) = .84 standard deviations); for mathematics there was a 24 point difference (ES = .47). Once again, the state-mandated results were similar to those for the CTB and are not shown.

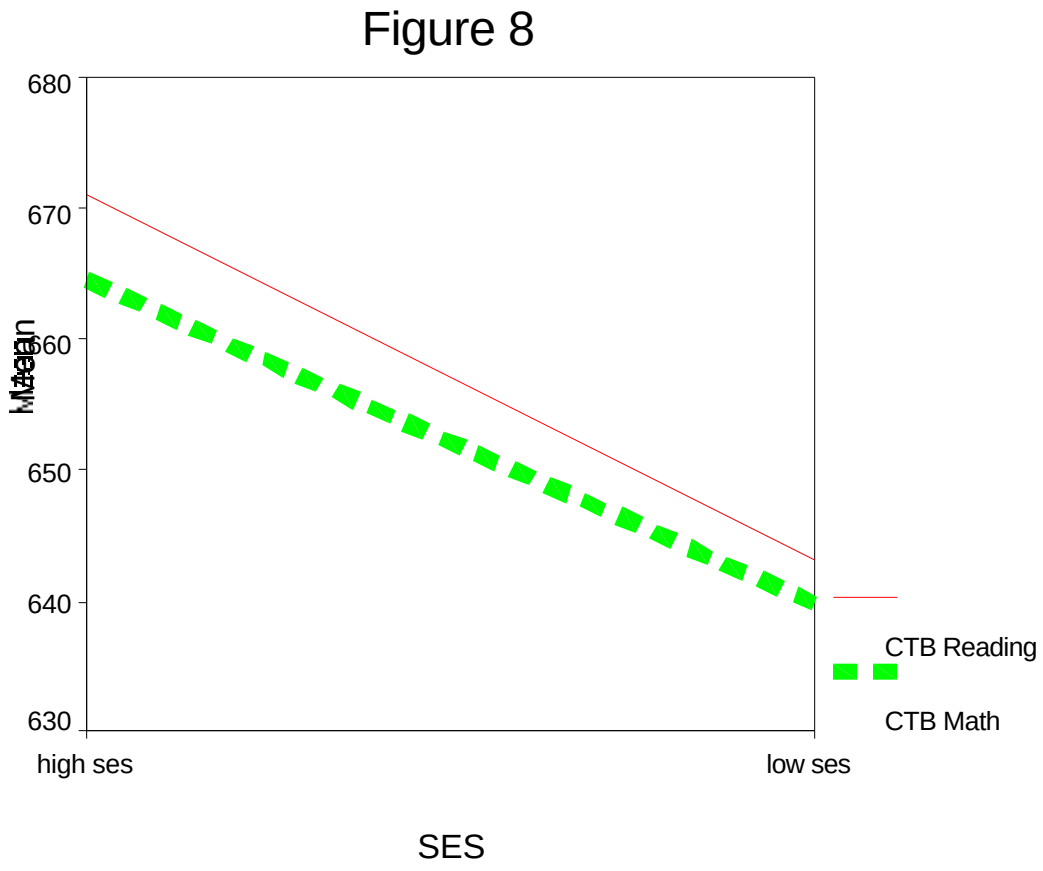


Figure 8:
Socio-economic status and District #2 student achievement on the CTB in reading and mathematics

LEP. As seen in Figure 9, students within each LEP group performed quite similarly in CTB reading and mathematics. For reading, as expected the proficient students scored substantially higher (more than 40 points) than those classified as not proficient (ES = 1.24), while for mathematics the gap was 37 points (ES = .73). The state-mandated results were even sharper than those for the CTB. For the ELA test, students proficient in English tended to score 55 points higher than those not proficient (ES = 1.36), while for mathematics the gap was 44 points (ES = 1.16).

Figure 9

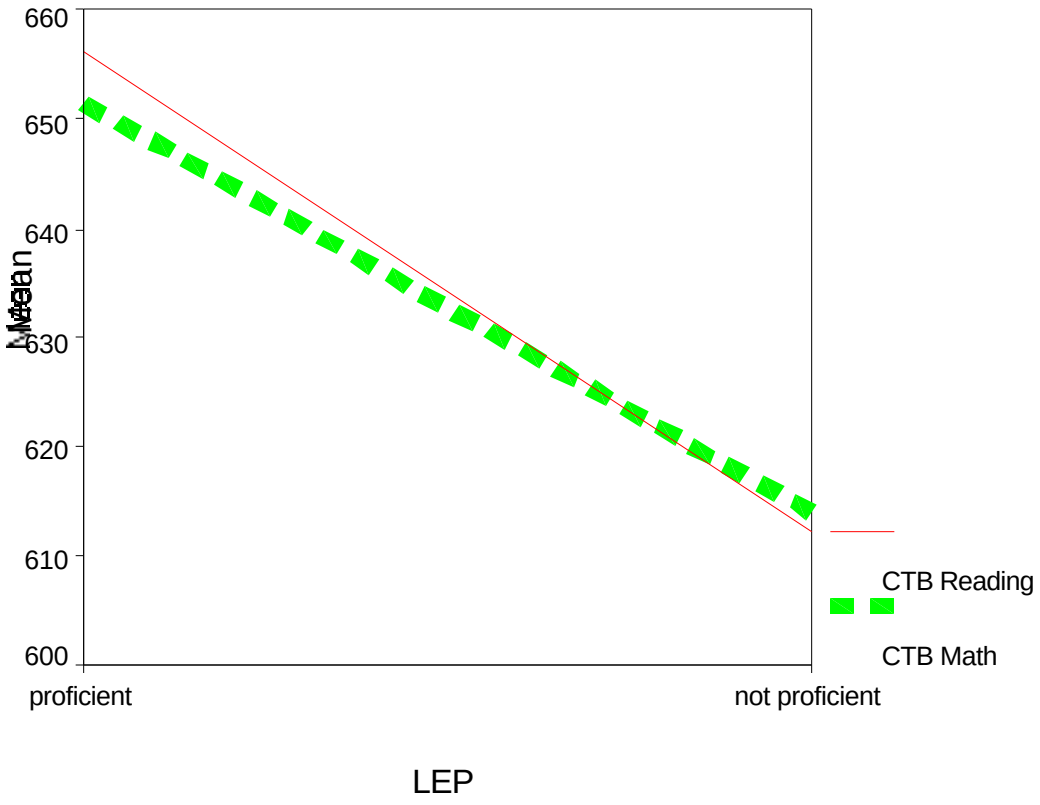


Figure 9:
English proficiency and District #2 student achievement on the CTB in reading and mathematics

Gender. As seen in Figure 10, there is a modest gender difference (6 points, ES = .16) in reading favoring females. For mathematics, males showed a slight advantage with a 2-point gap (ES = .04). The state-mandated tests showed greater differences in reading, with females outperforming males in reading by an average of 10 points (ES = .24). In mathematics, the results mimicked those of the CTB test, with males outperforming females by approximately 2 points (ES = .07).

Figure 10

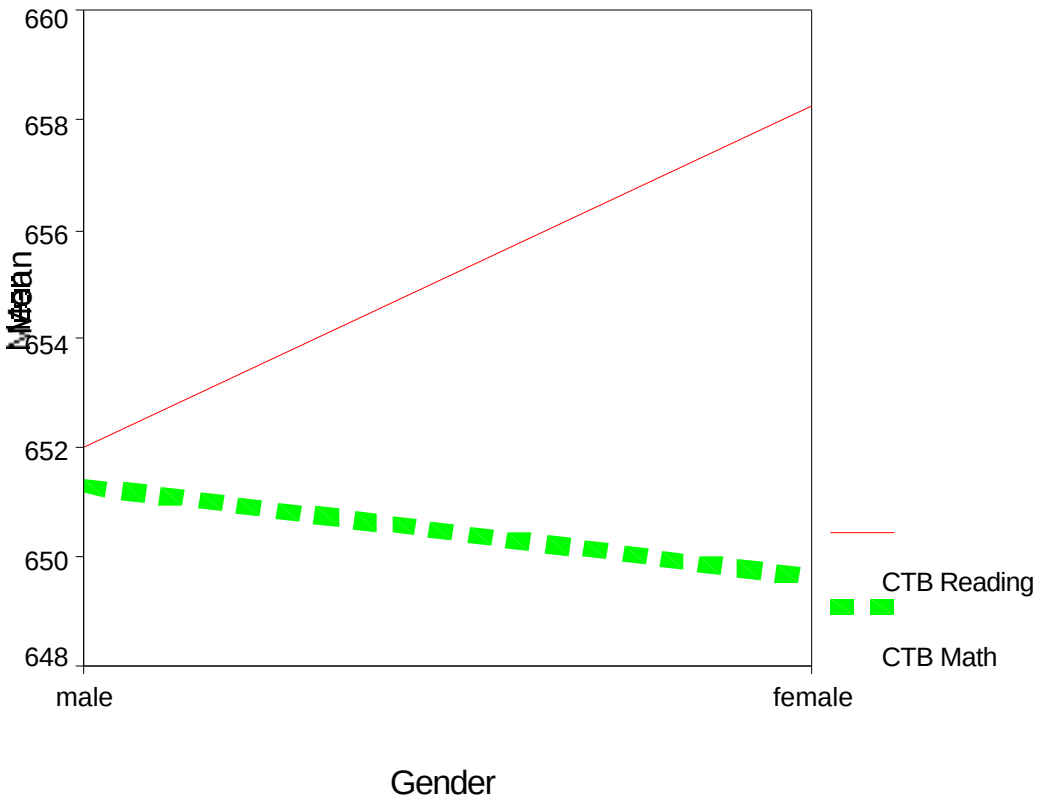


Figure 10: Gender and District #2 student achievement on the CTB in reading and mathematics

Ethnicity x SES. As seen in Figure 11, high SES students scored higher (on average) in reading regardless of their ethnicity. That is, the general rank-ordering of ethnic groups was Whites, Asians, Blacks, and Hispanics and emerged regardless of SES.

Figure 11

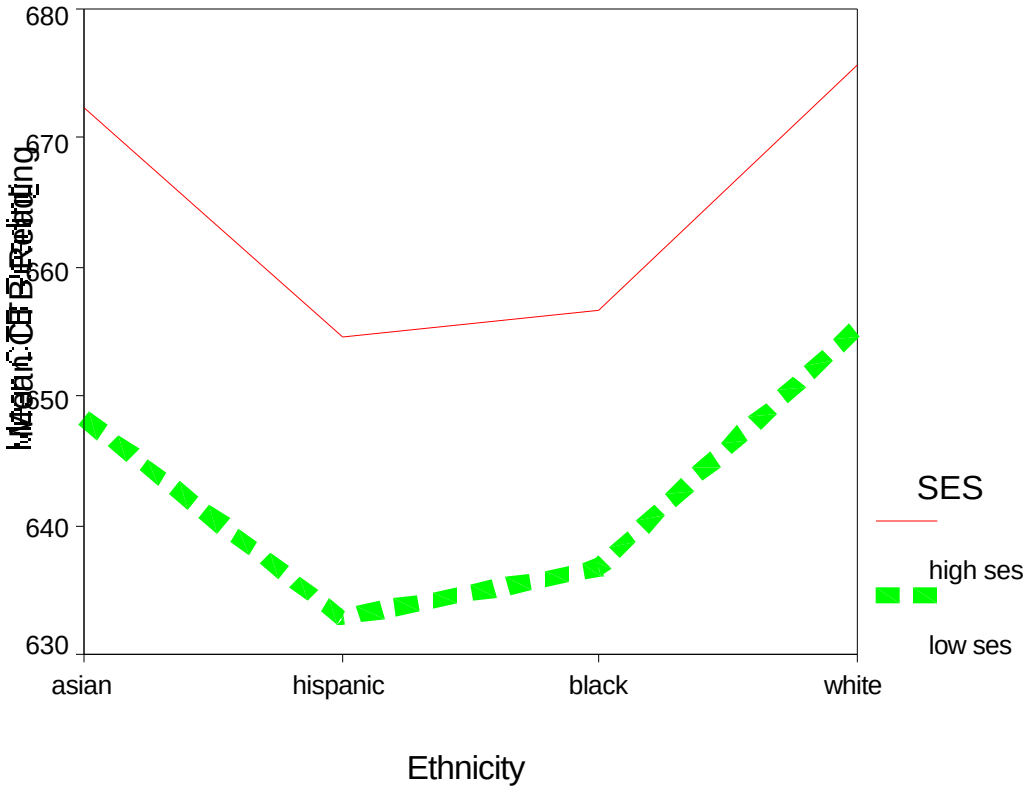


Figure 11:
Ethnicity, socio-economic status and District #2 student achievement on the CTB in reading

A slightly different rank-ordering emerged for mathematics, as seen in Figure 11. Here, Asian students scored the highest, followed by White, Hispanic, and Black students. The average gap favoring reading over mathematics was similar for Asians, Whites, and Hispanics (10, 8, and 13 points, respectively), and larger for Black students (19 points). For the state-mandated exams (not presented), the same general rank-ordering (White, Asian, Hispanic, Black) appeared for both reading and mathematics tests, with the average performance of Hispanic and Black students virtually identical. The average gap favoring reading over mathematics for the state tests for Whites, Blacks, and Hispanics was 11, 10, and 10, respectively. On the other hand, Asian students scored an average of 7 points higher in mathematics than reading on these exams.

Figure 12

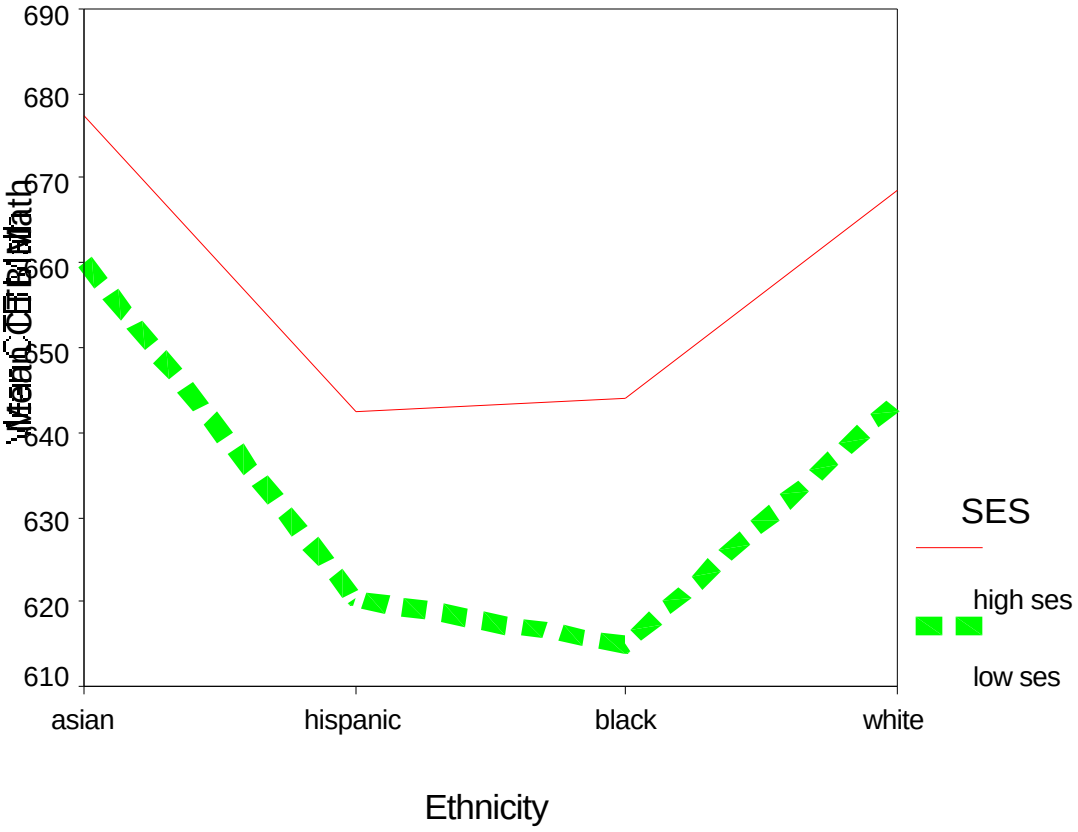


Figure 12
Ethnicity, socio-economic status and District #2 student achievement on the CTB in mathematics

Ethnicity x LEP. The results for Ethnicity x LEP for CTB reading in Figure 13 are quite similar to those for Ethnicity x SES. Even among LEP students, their performance in reading is uniformly better than in mathematics, with the rank-ordering Asian, White, Black, and then Hispanic students. As with SES, the rank-ordering changes slightly for mathematics, with Asian students scoring highest, followed by White, Hispanic, and Black students (Figure 14). When examining Figures 14 involving LEP it is important to remember that the number of students who were not proficient in English who sat for the reading and mathematics exams was quite small.

Figure 13

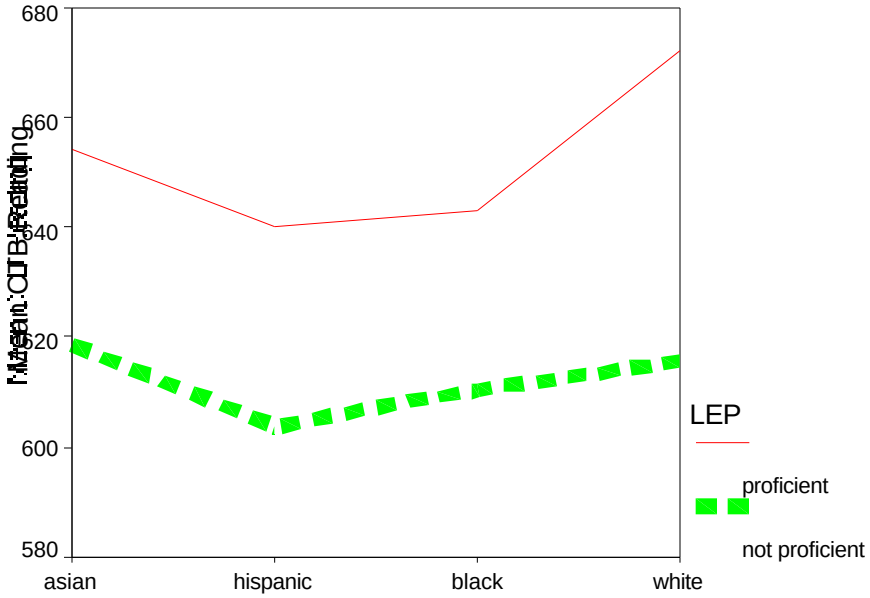
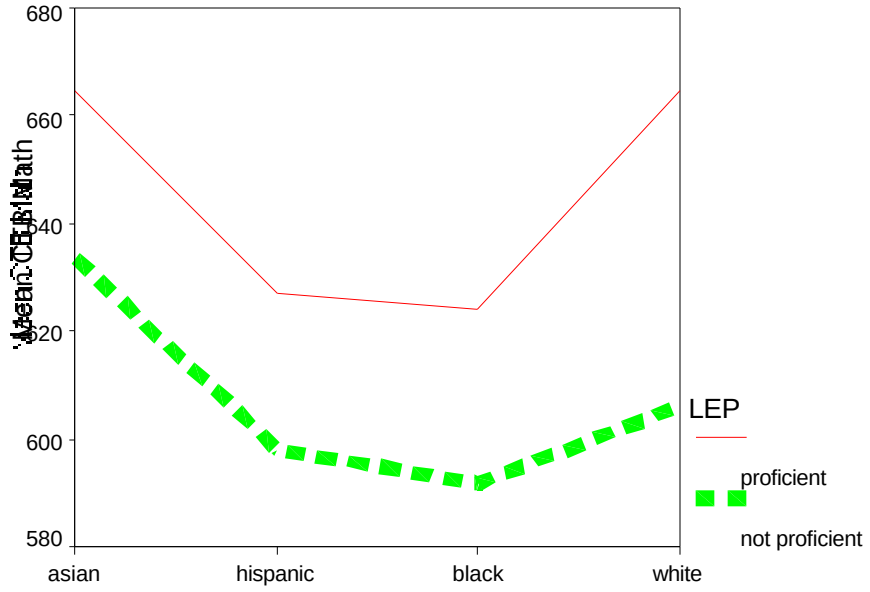


Figure 14



Figures 13 &14:
Ethnicity, English proficiency and District #2 student achievement on the CTB

Patterns for the state-mandated exams are different from those presented in Figures 13 and 14. The main difference for reading, presented in Figure 15, is that White students who were or were not proficient performed similarly (average of 685 vs 681). For mathematics (Figure 16), it was Black students who performed similarly regardless of their English status (635 vs 632).

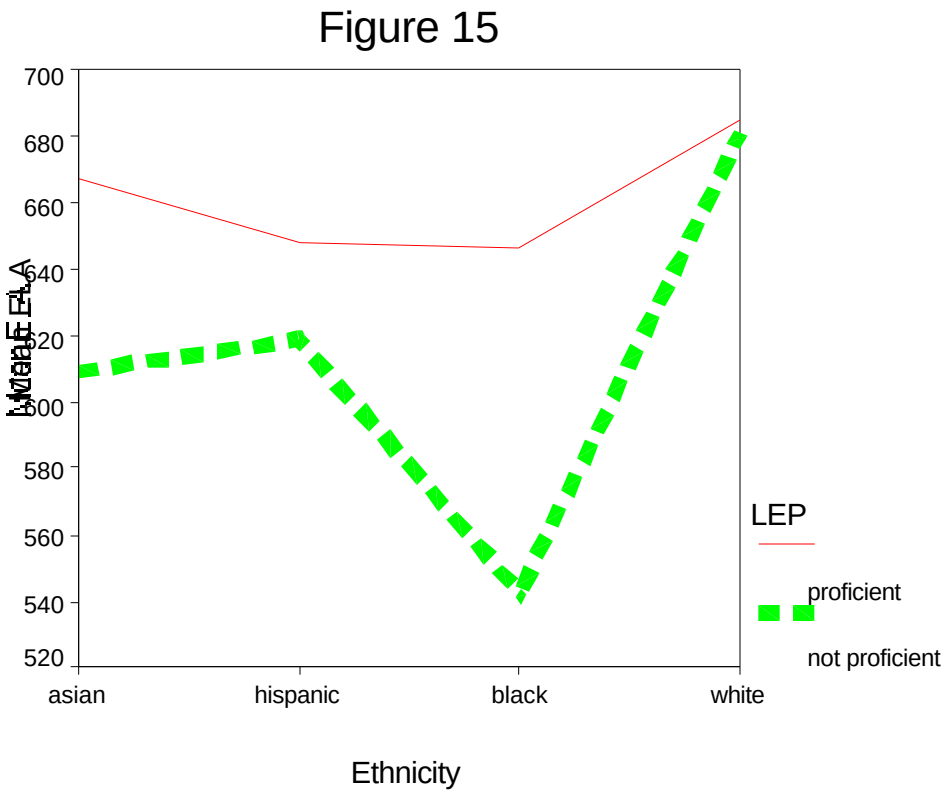


Figure 15: Ethnicity, English proficiency and District #2 student achievement on the state English language arts exam.

Figure 16

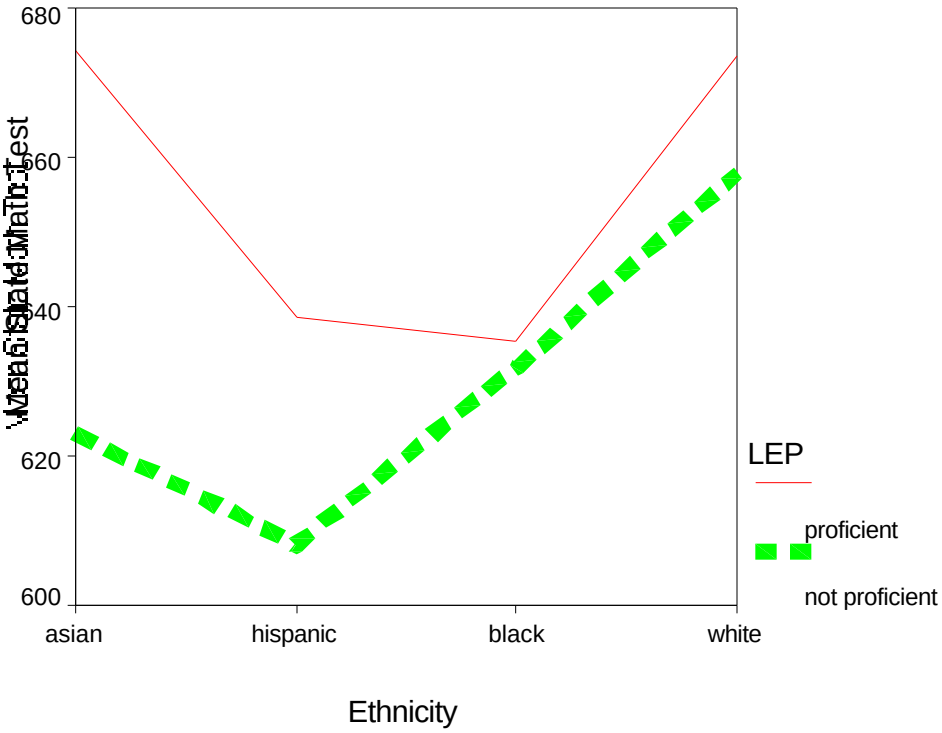


Figure 16: Ethnicity, English proficiency and District #2 student achievement on the state mathematics exam

SES x LEP. The results in Figure 17 indicate that even within the not proficient group, low SES students performed substantially lower in reading than those in the high SES group (mean = 638 vs 605). The results in Figure 18 for mathematics were similar to those for reading, with the average mathematics score of the not proficient group much lower than that of the proficient group (mean = 630 vs 609).

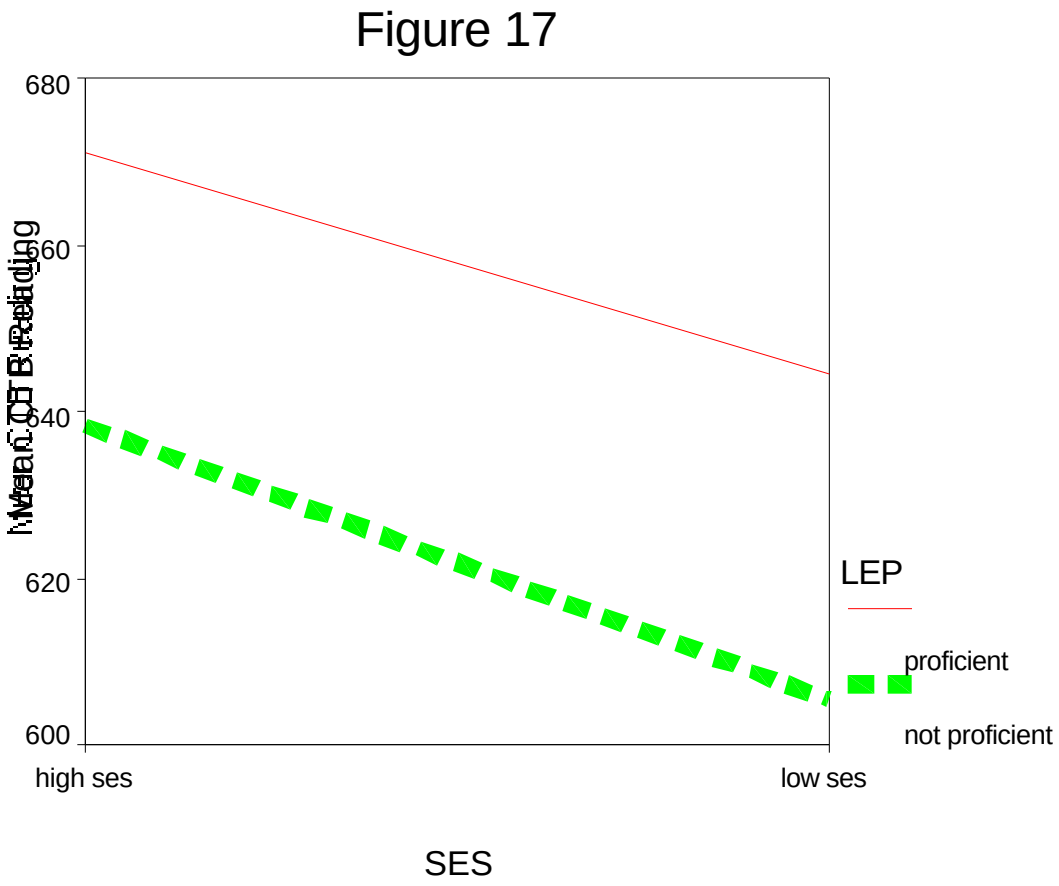


Figure 17:
Socio-economic status, English proficiency and student achievement on the CTB in reading

Figure 18

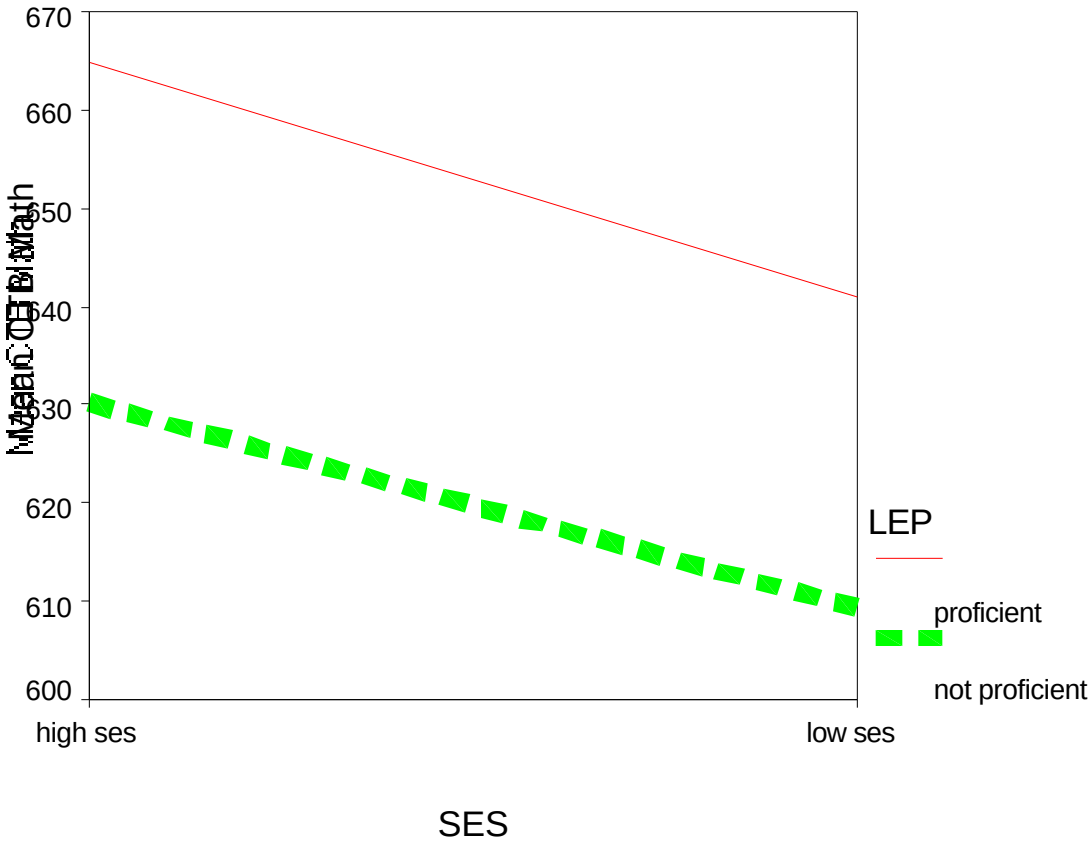


Figure 18:
Socio-economic status, English proficiency and student achievement on the CTB in mathematics

Technical Notes on HLM Analyses

The hierarchical structure of educational data (e.g., students nested within teachers/classrooms) requires the use of specialized data analysis models that take this structure into account. We used hierarchical linear modeling (HLM) to study patterns in the data using the HLM5 computer program (Raudenbush, Bryk, Cheong, & Congdon, 2000). We assume that the i = 1,2,.., n_j students (level 1) are nested within j=1,2,…,J classrooms (level 2), which are themselves nested within k = 1,2,…K schools, and that District #2 students, classrooms, and schools are representative of an identifiable population. We used a significance level of .05 for all statistical tests.

Four key data analysis issues surround our use of HLM. First, it is important that the sample sizes at various levels be large enough to ensure that parameters can be estimated with reasonable

accuracy. For example, the median within-classroom sample size in our HLM analyses was 24 and ranged from 8 to 34. In most cases this should ensure that within-classroom parameters are estimated with reasonable accuracy. Similarly, most of the level 2 analyses involved sample sizes that should be large enough to ensure that those parameters are estimated accurately (34-57 classrooms for analyses involving CTB reading and mathematics).

A second data analysis issue is that the statistical assumptions underlying these models need to be at least approximately satisfied to ensure credible inferences. To this end we examined residuals for the fitted models and found no serious evidence of nonnormality or heteroscedasticity. We took advantage of the capability of HLM5 to produce robust standard errors which are less sensitive to assumption violations, and we report these robust values in the tables below. We also examined possible model misspecification by plotting residuals against products of various predictor variables. These plots suggested that interaction-type predictors were not needed.

A third data analysis issue is the effect of missing data on our inferences. Both the student and teacher data contained missing values, but for HLM analyses missing data at the teacher level was more troublesome. Coupled with the fact that HLM analyses only permit missing data at the student level, these missing values raise several concerns, including the likelihood of inadequate sample sizes at level 2. For example, we obtained questionnaires from 57 elementary school teachers in grades 3 and 5 who could be linked to student achievement data, but several teachers failed to respond to at least one item. The median number of missing responses across 57 teachers for the subscales used in the HLM analyses were professional community (0), professional development in literacy (5), role of balanced literacy (0), professional development in mathematics (3), and TERC (1). The missing response patterns were sufficient to render the data of many teachers unusable for the HLM analyses. Fitting a particular two-level HLM model in which factor scores representing teacher responses to questionnaire items served as predictors at level 2 would, because of missing questionnaire data, reduce the number of teachers to a number that would raise questions about the credibility of the analyses (e.g., 15).

Because the amount of missing data for the teacher's responses was relatively modest we opted to impute teacher's missing values for the subscale items on the questionnaire using the EM-approach in the SPSS Missing Values Analysis (missing student data were not imputed). This approach imputes missing values using the information in available data. Essentially, this procedure fits regression models using predictors believed to account for the reasons data were missing (missingness) to data in which the variable with missing values is the dependent variable. The fitted values are then imputed for the missing values (McLachlan, & Krishnan, 1997). The

key assumption underlying this procedure is that missingness can be accounted for by explanatory variables in such a way that the missing values are missing at random (MAR), and these explanatory variables are in the data imputation model (Schafer, 1997). If MAR is satisfied (along with multivariate-normality), then the resulting estimators are unbiased and efficient. Fortunately, there is evidence that failure to precisely satisfy these assumptions still produces estimators with desirable statistical properties (Schafer, 1997, pp.26-27).

Once the teacher's responses for selected subscales were imputed factor scores were created for the now complete data and used in the HLM analyses—The descriptions of factor analysis and factor scores in table 14 were based on the incomplete data. The professional community and balanced literacy subscales had no missing data and so no imputation was done. Where possible, we performed analyses to assess the sensitivity of our findings to the use of imputed values. For example, correlations based on incomplete and imputed subscales for literacy using factors scores tend to be similar:

	Incomplete Teachers Data	Imputed Teachers Data
Quality Prof Dev, %LOWSES	-.24	-.12
Quality Prof Dev, Principal's Leadership	.63	.63
Quality Prof Dev, Balanced Literacy	.40	.35
Quality ProfDev, Prof Community	.70	.62
Balanced Literacy, CTB Reading	-.19	-.10

These correlations were generally similar to those reported in tables 9 and 10, although there were a few exceptions. For classroom-level regressions we fitted HLM models (see below) using the imputed data but we also used the AMOS (Arbuckle, 1999) program to estimate slopes for the incomplete data. AMOS employs Full Information Maximum Likelihood (FIML) estimation using available (incomplete) data under the MAR assumption and multivariate-normality. We found little evidence of strong differences in the estimated slopes and their standard errors using the FIML approach versus a data imputation approach.

Although many of the correlations/slopes are similar regardless of whether they are based on the incomplete or imputed teachers responses, it is important to emphasize that the credibility of the EM approach for imputing missing values depends on the validity of the MAR assumption, not the similarity of statistics like those presented above. Still, it is comforting when incomplete and imputed data produce similar findings.

A fourth data problem was that some of the student level predictors showed no variation within certain classrooms, meaning that those students and their classroom were removed from the

HLM analysis. For example, if all of the students in a classroom were in the low SES group then a regression model with this predictor could not be fitted to these data. In addition to SES, these problems emerged for the Ethnicity and LEP predictors. The loss of data because of a lack of variation can bias our findings.