Evaluation of the Texas Technology Immersion Pilot: First-Year Results

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1. Introduction

The Technology Immersion Pilot (TIP) sets forth a vision for technology immersion in Texas public schools that links ubiquitous access to technology with student achievement. The Texas Education Agency (TEA) directed nearly $14 million in federal Title II, Part D monies toward funding a wireless learning environment for high-need middle schools through a competitive grant process. A concurrent research project funded by a federal Evaluating State Educational Technology Programs grant is scientifically evaluating whether student achievement improves over time as a result of exposure to technology immersion. The Texas Center for Educational Research (TCER)—a non-profit research organization in Austin—is the TEA's primary partner in this landmark effort.

The overarching purpose of the study is to conduct a scientifically based evaluation at the state level to test the effectiveness of technology immersion in increasing middle school students' achievement in core academic subjects. Technology immersion encompasses multiple components, including a laptop computer for every middle school student and teacher, wireless access throughout the campus, online curricular and assessment resources, professional development and ongoing pedagogical support for curricular integration of technology resources, and technical support to maintain an immersed campus. The evaluation will examine the relationships that exist among contextual conditions, technology immersion, intervening factors (school, teacher, and student), and student achievement. Moreover, the research will determine the impact of immersion on student achievement in core subject areas as measured by the Texas Assessment of Knowledge and Skills (TAKS).

Theoretical Framework

The *Theoretical Framework for Technology Immersion* guides the evaluation (see Figure 1). The experimental design, as illustrated in the framework, allows an estimate of the effects of the intervention, which is the difference between the experimental and control groups. The framework also postulates a linear sequence of causal relationships. Program implementation comes first. Experimental schools are to be "immersed" in technology through the introduction of technology immersion resources. The quality of implementation reflects the strength of leadership and system support, robustness of wireless laptop access for teachers and students, how well online curricular and assessment resources are used, the extent to which professional development supports curricular integration of technology resources, and the adequacy of technical and pedagogical support services to maintain an immersed campus. Given quality implementation, we expect school-level improvements in measures of classroom technology integration, innovative culture, technical support, and parent and community support. Leadership and system support drives progress toward full immersion.

An improved school environment for technology should then lead to teachers who have greater technology proficiency and use technology more for their own professional productivity, collaborate more with their peers, have students use technology more in their classrooms, and use laptops as a tool to increase the intellectual challenge and relevance of lessons. In turn, these improved school and classroom environments should lead students to greater technology proficiency, more opportunities for peer collaboration, improved personal self-direction, and stronger engagement in school and learning. Student mediating variables presumably contribute to increased academic performance, as measured by standardized test scores. In the framework, links are also shown between student achievement and student, family, and school characteristics, which exert their own influence on learning. The study's theoretical framework has guided the evaluation design as well as the design of data collection procedures and measures. The research literature that undergirds the framework will soon be available at www.etxtip.info.

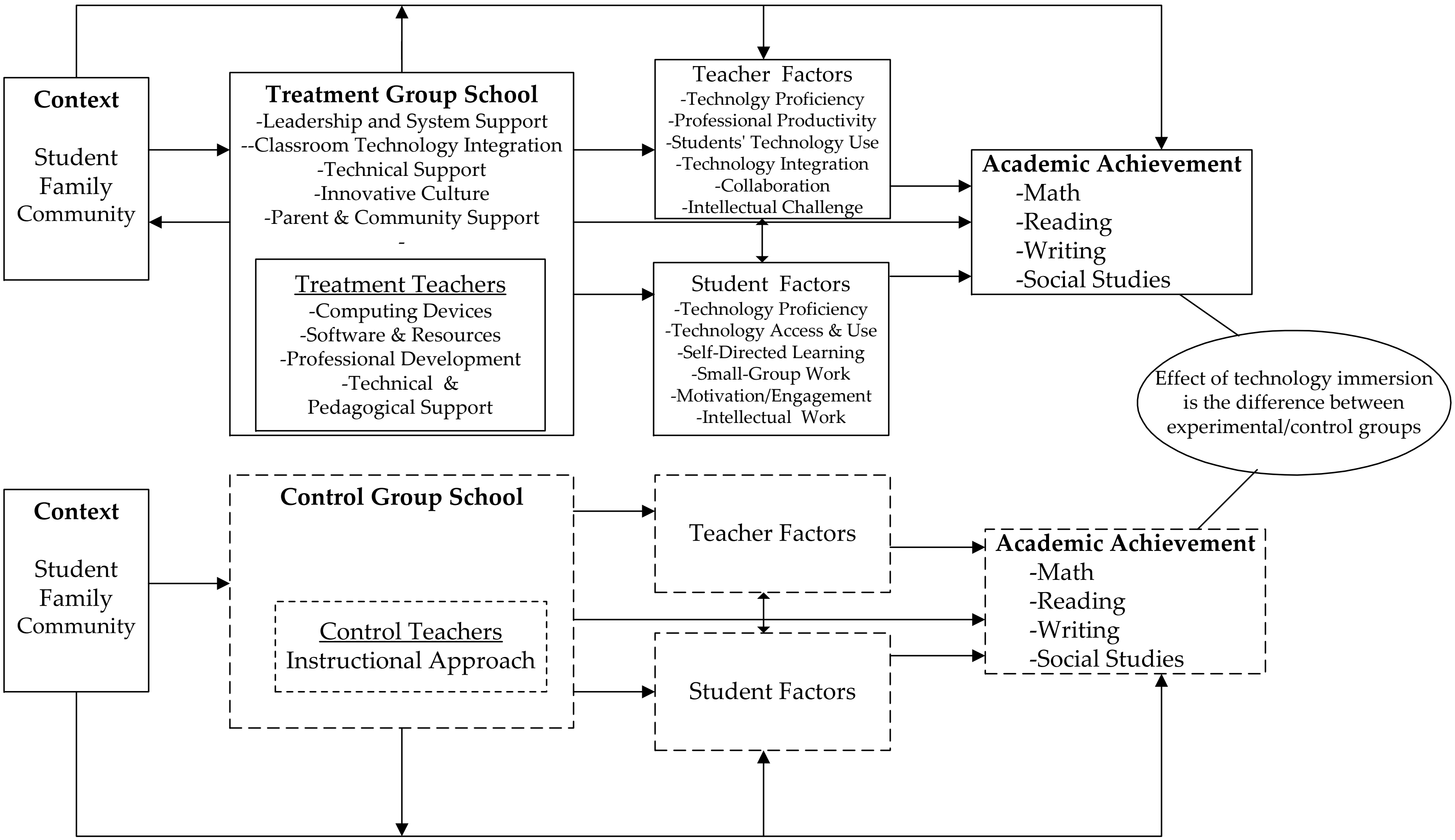
Study Questions

In the quasi-experimental research design, 44 middle schools were assigned to either treatment or control groups, with 22 schools in each. Researchers have posed six main research questions:

- What are the characteristics of participating schools?
- How is technology immersion implemented?
- What is the effect of technology immersion on schools?
- What is the effect of technology immersion on teachers and teaching?
- What is the effect of technology immersion on students and learning? and
- Does technology immersion impact student achievement?

This report concentrates on information gathered for the 44 participating middle school campuses during the 2004-05 school year. Data collection involved a mix of qualitative and quantitative data sources. Researchers conducted site visits in each of the middle schools in fall 2004 and again in spring 2005. For this report, we include site-visit data from surveys of technology resources and observations in core- subject classrooms. Additional measures, usually administered as pre-measures (fall 2004) and post-measures (spring 2005), include teacher and student surveys, and school and student data from the Texas Public Information Management System (PEIMS) and Academic Excellence Indicator System (AEIS).

Figure 1.1. Theoretical Framework for Technology Immersion



Organization of the Report

Report sections are organized around findings relative to the study's research questions. More specifically, key research areas that guided the synthesis of findings across the immersion and control sites are listed below.

- *Section 1, Introduction,* provides background on the TIP project and the study's theoretical framework. The section also establishes the purpose for the study and the research questions addressed.
- *Section 2, Methodology*, presents information on the evaluation design, characteristics of immersion and control schools, study limitations, study participants, data collection methods, and data analysis procedures.
- *Section 3, Baseline Characteristics of Participating Schools,* describes patterns of technology access and use prior to the technology pilot as a way to establish the comparability of treatment and control schools.
- *Section 4, Technology Immersion Pilot—First-Year Implementation,* includes information on progress made toward implementation in the first year.
- *Section 5, Effects of Technology Immersion on Schools and Teachers*, presents findings on the impacts of immersion on school-level variables, including leadership and system support, classroom technology integration, technical support, innovative culture, and parent and community support. Additional findings are for teacher variables: technology proficiency and professional productivity, students' use of technology, technology integration, and collaboration with peers, and the intellectual challenge of instruction.
- *Section 6, Effects of Technology Immersion on Students and Learning*, offers findings on the impacts of immersion on student mediating variables, including technology proficiency and use, technical problems, opportunities for small-group work, school satisfaction, self-directed learning, and engagement.
- *Section 7, Effect of Technology Immersion on Student Achievement,* presents findings on the impact of technology immersion on student academic achievement as measured by TAKS Reading and Mathematics assessments.

2. Methodology

Evaluation Design

The evaluation design is quasi-experimental with a carefully matched comparison group. The design aims to approximate a randomly assigned control group by matching immersion schools with non-immersion schools possessing similar pre-program characteristics. For this study, interested districts and associated middle schools responded to a Request for Application (RFA) offered by the Texas Education Agency (TEA) in spring 2004 to become technology immersion schools. Applicants to become Technology Immersion Pilot (TIP) sites had to meet eligibility requirements for Title II, Part D funds (i.e., high-need due to children from families with incomes below the poverty line, schools identified for improvement, or schools with substantial need for technology).

Twenty-two technology immersion schools, selected through the competitive grant process, were matched by researchers with 22 control schools on key characteristics, including size, regional location, demographics, and student achievement. The TIP grants targeted high-need schools, thus more than 60% of students come from economically disadvantaged backgrounds, with many schools in rural or isolated locations. Students are ethnically diverse, roughly 56% Hispanic and 9% African American.

The evaluation originally aimed for an experimental design with random assignment of 60 schools to treatment (n=30) and control (n=30) groups. Unfortunately, the recruitment of districts and related middle schools proved to be a major obstacle to the random assignment of schools due to funding restrictions (Title II, Part D) and the amount of available dollars ($14 million). It was anticipated that grants would be awarded in amounts up to $350,000 to support technology immersion in grades 6 through 8 middle schools. State-level statistics revealed an available pool of 486 middle schools.

Treatment Sample

In January 2004, the Texas Education Agency (TEA) released a Request for Application (RFA) for school districts to receive TIP grants for up to two middle schools. During this initial round, only 14 eligible districts applied—of these, 11 were small districts with one middle school campus, and 3 were larger districts with multiple middle schools. The majority of applicants had 300 or fewer students at their campus. The TEA held an external review of proposals in early May. Applications were scored by five readers and scores were rank ordered. Following the external review, researchers and agency staff reviewed proposals to ensure that applications met the criteria established for technology immersion.

At this point, researchers knew that a second round of applications would be necessary, so first-round choices concentrated on the selection of small schools for the treatment sample. In the selection process, researchers considered factors such as (a) RFA rating scores, (b) district and campus size—small, mid-size, and large, (c) regional location (i.e., Education Service Center region), (d) the proportion of economically disadvantaged and minority students, and (e) the percentage of students passing TAKS (All Tests). Five small middle schools (300 or fewer students) and one large middle school (900 students) were chosen in the first round of RFAs.

To increase the pool of middle schools for the evaluation study, a second RFA for TIP grants (Round 2) was released in late May 2004. Additional recruitment efforts were undertaken through phone, email, mailings, and a videoconference for potential TIP grant applicants. In an effort to attract larger districts and middle schools, the RFA funding formula was modified to increase the amount of grant funds. The amount awarded to a participating campus was tied to campus enrollment: 350 students or less (up to $350,000), 351-600 students (up to $600,000), and greater than 600 students ($750,000). Non-funded applicants from Round 1 also were eligible to reapply and all but two districts did so.

During the second round, 22 eligible schools applied. Comparable to Round 1, expert reviewers rated the 22 proposals, and 19 proposals with a score 85 or above were eligible for selection. The selection process for treatment schools mirrored the first round. Researchers considered proposal ratings, size, location, student diversity, and academic achievement. Decisions were strongly influenced by the need for geographic distribution and the availability of comparable schools for the control group pool. Of the 19 proposals, 16 middle schools were selected for the treatment group (immersed campuses). The 3 non-selected campuses became part of the pool of middle schools available for the control group. These campuses had proposal scores comparable to selected campuses (at least 85 points)—however, they were not selected due to other considerations (i.e., geographic location and invoking the two-campus limit per district).

Of the 22 treatment schools, 14 are in small, single middle school districts (enrolling less than 3,000 students), 7 are schools in large districts (enrolling 10,000 or more students and having multiple middle schools), and 1 is a campus charter school in a large urban district (with more than 200,000 students). In sum, the originally envisioned random assignment of schools to experimental and control groups was not possible since the applicant pool did not include enough schools. Instead, researchers have used a matched control group research design, with experimental and control group campuses matched on key demographic and achievement variables. The sample size is considered adequate to detect a small effect size (.25 or larger) (Cohen, 1988).

Control Sample

The selection of control campuses involved several steps. First, in order to increase the available pool of middle schools that would be eligible to receive federal funds for participation in the study, researchers generated a pool of eligible grades 6-8 campuses from a list of districts that had previously received TARGET grants (Technology Applications Readiness Grants for Empowering Texas), competitive grants funded with Title II, Part D funds. Thus, the control pool now included 251 middle school campuses in districts receiving TARGET funds and 6 schools that had applied for and earned proposal rating scores that qualified them for TIP funds (3 in each of the two rounds). Of these campuses, 63 had 600 or fewer students and 194 had 601 or more.

As a next step, researchers identified middle schools that matched treatment campuses as nearly as possible on factors, including (a) district and campus size, (b) regional location, (c) the proportion of economically disadvantaged and minority students, (d) percentage of students passing all TAKS tests, and (e) the gaps between the percentage of White students and African American and Hispanic students passing TAKS (All Tests). Selection involved the use of *SPSS* statistical procedures to establish parameters around each variable of interest. Thus, a computer-generated list of “best matches” for each treatment school was created. In addition, grant specifications required large districts with multiple middle schools to provide access to control campuses within their own district, assuming a comparable school was available, so these schools were added to the list.

The final selection process for the control group involved a review of the matched list by a team of six researchers to identify the optimal control school for each treatment school. Additional schools were selected as alternates in the case that a selected control site declined the invitation to participate in the study. This selection process yielded 22 control group schools including controls for 8 campuses that came from within the same districts as the treatment schools and controls for 14 campuses from closely matched single, middle school districts. Similar to the experimental group, the 22 control schools included 13 in small, single middle school districts (enrolling less than 3,000 students), 8 schools in large districts (enrolling 10,000 or more students and having multiple middle schools), and 1 campus charter school in a large urban district (with more than 200,000 students). Each control school received $50,000 for study participation, with 25% of funds earmarked for professional development as required by Title II, Part D guidelines.

Characteristics of Participating Schools

The schools participating in the study are compared in Table 2.1 by assignment (treatment and control) and student enrollments. The distribution of middle schools across campus and district enrollment categories clearly shows the comparability of treatment and control groups. For both groups, middle schools are typically small (enrolling 600 students or less), and they are located either in small or very small districts (enrolling 2,999 students or less) or large districts (enrolling 10,000 students or more).

Table 2.1. Campus and District Enrollment by Comparison Group

	Immersion *N*=22		Control *N*=22	
Number of students	Number	Percent	Number	Percent
Campus				
300 or less	12	54.5	12	54.5
301-600	5	22.7	5	22.7
601 or more	5	22.7	5	22.7
District				
999 or less	8	36.4	8	36.4
1,000-2,999	6	27.3	5	22.7
3,000-9,999	0	0.0	0	0.0
10,000 or more	8	36.4	9	40.9

Information in Table 2.2 compares the baseline characteristics of immersion schools and the control schools. Results for *t*-tests show that the percentages of economically disadvantaged, minority, English as a second language (ESL), and special education students are statistically equivalent across the treatment and control schools. Likewise, results for student enrollment, mobility, and TAKS passing rates for all tests taken also showed no significant differences. Consequently, the treatment and control schools are sufficiently well matched on key demographic and academic performance measures.

Table 2.2. Comparison of Baseline Characteristics: Technology Immersion (*N*=22) and Control Schools (*N*=22)

				95% Confidence Interval for Difference		
Variable	Condition	Mean	*SD*	Lower	Upper	*t*(43)
Enrollment	Immersion Control	394 432	351.6 382.2	-185.6	261.3	0.34
Economic disadvantage (%)	Immersion Control	71.3 63.0	17.3 18.5	-19.2	2.6	-1.54
Minority (%)	Immersion Control	69.1 61.7	28.1 27.4	-24.3	9.5	-0.89
ESL (%)	Immersion Control	12.9 6.1	17.0 9.7	-15.4	1.6	-1.64
Special education (%)	Immersion Control	14.6 15.3	5.4 4.5	-2.4	3.7	0.45
Student mobility (%)	Immersion Control	15.7 16.7	4.5 6.1	-2.3	4.2	0.60
TAKS 2004, Passing All (%)	Immersion Control	51.1 53.1	16.5 12.3	-6.8	10.9	0.47
TAKS 2003, Passing All (%)	Immersion Control	65.5 67.0	11.3 12.1	-5.6	8.6	0.42

Source: Texas Education Agency AEIS reports 2004
Note. TAKS=Texas Assessment of Knowledge and Skills. Differences between groups are statistically insignificant.

Moreover, both treatment and control samples include a range of campus and district enrollments and schools from diverse regions of the state. In these respects, the sample selection process and matching procedures appear to have produced a baseline sample of schools with good internal validity, in that there are no large, statistically significant treatment-control differences. Still, the tendency for immersion schools to enroll greater proportions of minority and economically disadvantaged students may be important considering known links between disadvantaged status and lower achievement.

Table 2.3 provides campus-level data for each of the 44 schools recruited for the study. Data in the table show that the treatment and control schools are reasonably well matched on baseline characteristics. Middle schools are highly concentrated in rural and very small districts across the state. Still, about a third of the districts and schools are in large cities or suburban locations in or around cities. The sample also includes campus charter schools (one each for the treatment and control group) located in a major urban district.

Table 2.3. Characteristics of Technology Immersion and Matched Control Schools

Campus	Location			Students							
	District	District Enroll-ment	Community Type	Grades 6, 7, 8 Number	White (%)	African American (%)	Hispanic (%)	ESL (%)	Special Ed (%)	Eco Disadv (%)	Mobility (%)
Immersion											
Fruitvale Middle	Fruitvale	448	Rural	100	93.0	1.0	6.0	1.0	29.0	62.0	14.6
McLeod Middle	McLeod	478	Rural	138	93.5	4.3	1.4	0.0	17.4	44.2	14.6
Monte Alto Middle	Monte Alto	501	Rural	151	4.0	0.0	96.0	19.2	13.9	90.1	14.3
De La Paz Middle	Riviera	511	Rural	123	35.0	0.8	63.4	6.5	17.1	62.6	12.9
Charlotte Junior High	Charlotte	514	Rural	118	16.9	0.0	83.1	1.7	17.8	66.1	12.0
Memphis Middle	Memphis	530	Rural	124	46.8	12.9	40.3	12.9	19.4	65.3	14.6
Morton Junior High	Morton	540	Rural	117	23.9	11.1	64.1	5.1	9.4	78.6	12.2
Post Middle	Post	986	Non-metro: Stable	207	45.4	6.8	46.9	0.0	14.5	56.5	27.1
Floydada Junior High	Floydada	1,041	Non-metro: Stable	240	32.5	4.2	63.3	11.3	10.8	63.3	15.1
Newton Middle	Newton	1,307	Non-metro: Stable	299	53.8	41.8	2.0	0.3	18.1	57.9	18.8
Dublin Middle	Dublin	1,331	Non-metro: Stable	309	53.7	0.3	45.3	5.2	12.6	64.4	17.2
Brady Middle	Brady	1,385	Non-metro: Stable	295	54.9	3.1	41	1.4	19.3	62.0	14.5
Franco Middle	Presidio	1,516	Non-metro: Stable	341	0.6	0.0	99.1	38.1	10.6	93.5	15.0
Bernarda Junior High	San Diego	1,542	Non-metro: Stable	354	1.1	0.3	98.6	11.9	13.8	82.5	11.5
Wilson Middle	Port Arthur	10,356	Central city sub.	795	2.3	70.7	19.1	0.0	11.4	83.3	14.0
Austin Middle	Bryan	14,104	Central city	962	32.7	19.4	47.1	6.1	12.4	65.0	21.7
Woodland Acres Middle	Galena Park	20,388	Major suburban	416	7.2	7.0	85.8	22.8	11.1	85.6	12.0
Cigarroa Middle	Laredo	24,359	Central city	1,447	0.3	0.1	99.6	57.3	18.9	99.4	17.1
Memorial Middle	Laredo	24,359	Central city	713	0.7	0.0	99.3	51.6	19.1	97.5	20.1
Baker Middle	Corpus Christi	39,185	Central city	861	21.7	2.2	71.8	0.8	9.5	49.0	17.9
Cullen Middle	Corpus Christi	39,185	Central city	448	37.1	1.3	61.4	0.9	13.2	44.9	23.0
Kaleidoscope (Charter)	Houston	211,157	Major urban	110	0.9	6.4	90.9	30.0	1.8	96.4	6.1
Immersion school means				**394**	**29.9**	**8.8**	**60.3**	**12.9**	**14.6**	**71.3**	**15.7**

Table 2.3. Characteristics of Technology Immersion and Matched Control Schools (Continued)

Campus	Location: District	District Enroll-ment	Community Type[a]	Students: Grades 6, 7, 8 Number	White (%)	African American (%)	Hispanic (%)	ESL (%)	Special Ed (%)	Eco Disadv (%)	Mobility (%)
Control											
Ore City Middle	Ore City	817	Non-metro: Stable	203	85.2	6.9	7.9	0.5	18.2	50.7	19.9
Harleton Junior High	Harleton	624	Rural	155	97.4	2.6	0.0	0.0	12.3	25.2	15.9
Hamlin Middle	Hamlin	522	Rural	106	54.7	6.6	37.7	0.0	23.6	65.1	22.0
O'Donnell Junior High	O'Donnell	373	Rural	83	44.6	0.0	55.4	0.0	18.1	67.5	17.3
Odem Junior High	Odem-Edroy	1,175	Non-metro: Stable	287	19.5	0.0	80.1	2.8	11.5	53.3	11.3
Wellington Junior High	Wellington	555	Rural	141	55.3	7.1	37.6	7.8	16.3	62.4	12.2
Seagraves Junior High	Seagraves	589	Rural	142	26.1	11.3	61.3	2.8	21.1	63.4	6.5
Skidmore-Tynan Jr. Hi.	Skidmore-Tynan	713	Rural	176	35.8	0.6	63.6	1.7	16.5	60.2	18.8
Slaton Junior High	Slaton	1,382	Non-metro: Stable	335	36.1	8.7	54.9	2.1	12.5	61.5	18.6
Timpson Middle	Timpson	568	Rural	140	65.7	29.3	4.3	2.1	12.1	60.7	18.6
Cameron Junior High	Cameron	1,638	Non-metro: Stable	372	43.5	19.9	36.3	1.3	11.8	63.2	11.0
Coleman Junior High	Coleman	1,025	Non-metro: Stable	248	71.8	1.6	25.8	0.0	13.3	54.0	22.3
Truman Middle	Edgewood	12,873	Major suburban	482	0.2	0.2	99.6	10.6	21.2	96.9	25.3
Newman Middle	Cotulla	1,264	Central city sub.	281	8.5	0.0	91.5	14.2	13.5	82.9	13.9
Austin Middle	Port Arthur	10,356	Central city sub.	503	16.7	58.8	19.1	0.0	3.2	67.4	25.0
Rayburn Middle	Bryan	14,104	Central city	1,190	51.4	27.1	20.8	2.4	11.1	47.6	16.2
Galena Park Middle	Galena Park	20,388	Major suburban	1,009	5.0	8.5	86.4	15.5	13.8	78.3	12.7
Lamar Middle	Laredo	24,359	Central city	1,390	1.3	0.2	98.1	26.6	17.7	90.1	14.8
Faulk Middle	Brownsville	48,857	Central city	888	0.8	0.0	99.2	37.6	19.3	99.1	18.0
Hamlin Middle	Corpus Christi	39,185	Central city	805	25.8	3.7	69.9	1.1	17.4	56.5	19.3
Haas Middle	Corpus Christi	39,185	Central city	476	65.4	6.5	59.5	0.6	18.9	50.6	26.4
Briarmeadow (Charter)	Houston	211,157	Major urban	89	48.3	15.7	32.6	3.4	12.4	29.2	1.5
Control school means				**432**	**37.6**	**9.8**	**51.9**	**6.1**	**15.3**	**63.0**	**16.7**
Immersion school means				**394**	**29.9**	**8.8**	**60.3**	**12.9**	**14.6**	**71.3**	**15.7**
Overall school means				**413**	**33.7**	**9.3**	**56.1**	**9.5**	**14.9**	**67.2**	**16.2**

Source. Texas Education Agency AEIS reports 2004.

[a] Community Type: Major urban (six largest districts in the state), Major suburban (other school districts in and around major urban areas), Central city (largest districts in other large, but not major, Texas cities), Central city suburban (school districts in and around the other large, but not major, Texas cities), Independent town (largest districts in counties with 25,000 to 100,000), Non-metro: Fast growing (school districts smaller than other categories, exceed state median, and have 5-year growth rate of 20%), Non-metro: Stable (school districts smaller than other categories, exceed state median, and have stable growth), Rural (number of students is between 300 and the state median or less than 300).

The primary limitation of the study is external validity, the extent to which the results of an experiment can be generalized from the specific sample to the general population. Schools eligible to become part of the treatment group were limited to those serving children from families living in poverty[1] and grades 6 to 8 middle schools. Only schools that applied for the grant, and submitted applications that met a threshold of quality, were eligible for consideration. Due to these restrictions, the treatment group is not expected to be representative of the average middle school in Texas.

The majority of students in the sample are economically disadvantaged. The percentage of sample students who qualify for federal free or reduced-price lunch exceeds the state average for middle schools (67% vs. 51%), and students at immersed campuses qualify at a somewhat higher rate than control students (71% vs. 63%). The sample also is substantially more Hispanic and less White and African American than state middle-school students as a whole. Overall, about 56% of sample students are Hispanic compared to about 37% of Texas middle school students. Accordingly, compared to the state, the sample includes less African American students (9% vs. 14%) and less White students (34% vs. 46%). The proportion of minority students is similar for treatment and control schools (69% vs. 62%). Accordingly, external validity—the extent to which findings for the sample generalize to the population—is a concern in that the sample departs substantially from the demographic characteristics of the state's middle-school students. Moreover, sample schools differ structurally from Texas middle schools as a whole, which typically enroll more students (609 on average vs. 413) and are concentrated in larger districts (27,000 students enrolled, on average vs. 18,737).

Participants

Students

Table 2.4 shows that three groups or cohorts of students will be followed in this study. One of these cohorts (grade 6 in 2004-05) will be followed for four years, one cohort (grade 6 in 2005-06) will be followed for three years, and one cohort (grade 6 in 2006-07) will be followed for two years. Data collection activities in 2004-05 centered on the initial sixth-grade cohort, which included a total of 5,564 students (2,570 enrolled at immersed campuses and 2,994 students at control campuses).

Table 2.4. Student Cohorts by School Year and Grade

	Middle School			High School
Year	Grade 6	Grade 7	Grade 8	Grade 9
2004-05	Cohort 1			
2005-06	Cohort 2	Cohort 1		
2006-07	Cohort 3	Cohort 2	Cohort 1	
2007-08		Cohort 3	Cohort 2	Cohort 1

Similar to schools as a whole, about three-fourths of sixth-grade students are economically disadvantaged (see Table 2.5). Comparison groups also have nearly equal

[1] Federal definition used: 27% of population or more than 2,500 people living below poverty line.

proportions of minority students and female and male students. The main difference between groups is the greater proportion of limited English proficient (LEP) students in immersed schools.

Table 2.5. Demographic Characteristics of Sixth Grade Students: 2004-05

Characteristic	Immersion		Control	
	N	Percent	*N*	Percent
Enrollment	2,570	--	2,994	--
Economic disadvantage	1.971	76.7	2,243	74.9
Ethnicity				
African American	303	11.8	339	11.3
Hispanic	1,708	66.5	1,916	64.0
White	523	20.4	716	23.9
Other	36	1.4	23	0.8
Limited English proficient	522	21.5	474	15.8
Gender				
Female	1,209	47.0	1,452	48.5
Male	1,361	53.0	1,542	51.5

Teachers

During the 2004-05 school year, 1,304 teachers participated in the study (622 at immersed campuses and 682 at control campuses). Teachers in comparison groups are remarkably similar in terms of gender, ethnicity, advanced degrees, and average teaching experience.

Table 2.6. Demographic Characteristics of Teachers: 2004-05

Characteristic	Immersion	Control
Number of teachers	622	682
% Female	65.4	68.8
% Minority	42.4	35.3
% African American	7.8	7.5
% Hispanic	32.2	26.3
% White	57.6	64.7
% with no degree	0.0	2.0
% with advanced degree	21.7	22.2
Average years of teaching experience	10.9	11.4

Note. There were 1,304 teachers in 2004-05.

Data Collection

Data collection began in fall 2004 and will continue through the 2005-06 school year (and possibly beyond). As Table 2.7 illustrates, researchers conducted site visits in each of the 44 middle schools in fall 2004 and spring 2005. For this report, we concentrate on data gathered through observations in a sample of sixth-grade classrooms (English/language arts, mathematics, social studies, and science). Additional measures, administered as pre- and post-measures in fall and spring, include a Campus Technology Inventory completed by the campus technology coordinator, teacher online surveys, and student surveys. Additionally, we gathered school and student demographic, attendance, and achievement data from the Texas Public Information Management System (PEIMS) and Academic Excellence Indicator System (AEIS). In spring 2005, individual middle schools submitted student-level data on disciplinary actions.

Table 2.7. Time Frame for Data Collection, 2004-05

	Fall 2004	Spring 2005
Site Visits		
Building walkthrough	X	X
Classroom observations (6th grade)	X	X
Other Measures		
Campus Technology Inventory	X	X
Teacher Technology Survey (all teachers)	X	X
Student Technology Survey (6th grade)	X	X
Style of Learning Inventory (6th grade)	X	X
Student Performance		
Texas Assessment of Academic Skills (TAKS)		X[a]
Attendance		X[a]
Discipline referrals and placements		X

Note. Data collection for 22 immersion and 22 control schools.
[a] TAKS and attendance data were also collected for spring 2003 and 2004.

Measures

Instruments, selected to measure mediating and outcome variables, included technology inventories, teacher and student surveys, classroom observation form, and student performance measures.

Teacher survey. Immersion and control teachers (grades 6 to 8) completed an online technology survey in fall 2004 (September to October) and spring 2005 (April to May). The survey included items related to school technology and teachers' technology proficiency and use. In fall, 1,271 teachers completed the survey (97% of grades 6-8 teachers, 97% of immersed teachers, and 98% of control teachers). In spring, 1,144 teachers (about 88% of all teachers, 87% of immersed teachers, and 88% of control teachers) completed the survey.

School mediating variables. Teachers responded to 33 items pertaining to their perceptions of school technology. They rated the strength of their agreement with statements on a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Items were analyzed using maximum likelihood factor analysis with Varimax rotation. Five distinct factors emerged, including Leadership and System support (12 items), Classroom Technology Integration (4 items), Technical Support (5 items), Innovative Culture (4 items), and Parent and Community support (2 items). Measures of internal consistency for school-level factors range from 0.67 to 0.91.

Teacher mediating variables**.** Surveys completed by grades 6 to 8 teachers also included measures of teacher mediating variables. Teachers responded to items pertaining to their perceptions of technology, including their Technology Proficiency (27 items) and Professional Productivity (17 items), Students' Classroom Technology Use (17 items), and Collaboration (11 items related to teacher interactions with colleagues). In addition, confirmatory analysis of items adapted from the Levels of Technology Implementation (LoTi) Questionnaire (Moersch, 2001) showed reasonable fit indices for a model having Technology Integration (10 items), Learner-Centered Instruction (4 items), and Resistance to Integration (3 items). Measures of internal consistency for all of these teacher-level variables ranged from a low of 0.70 (the 3-item Resistance to Integration scale) to a high of 0.97 (the 27-item Technology Proficiency scale).

For Technology Proficiency items, teachers indicated their skill level on a 7-point scale with 1 and 2 indicating low proficiency (*not true of me now*), 3, 4, and 5 indicating moderate proficiency (*somewhat true of me now*), and 6 and 7 indicating proficiency (*very true of me now)*. Measures of integration—Technology Integration, Learner-Centered Instruction, and Resistance to Integration—also involved a 7-point scale ranging from 1 (*not true of me now*) to 7 (*very true of me now*). For Professional Productivity, Student Technology Use, and Collaboration, teachers used a 5-point scale to rate the frequency of activities or interactions: 1 (*never*), 2 (*rarely–e.g., a few times a year),* 3 (*sometimes–e.g., once or twice a month)*, 4 (*often*–e.g., *once or twice a week)*, and 5 (*almost daily*).

Student surveys. Sixth-grade students completed paper-and-pencil questionnaires measuring students' technology proficiency and use in fall 2004 (September to October) and spring 2005 (April to May). In addition, they completed the Style of Learning Inventory (SLI). The SLI is a measure of student self-directed learning (i.e., self-generated behaviors oriented toward the attainment of learning goals). The SLI, which was also a paper-and-pencil questionnaire, was administered as a baseline measure in fall and as a post-measure in spring.

Technology survey**.** In fall, 4,824 sixth-grade students (87%) completed the survey. Respondents included 2,319 treatment students (90%) and 2,505 control students (84%). In spring, 4,538 students (82%) completed the survey, with 2,053 treatment (80%) and 2,485 control students (83%). Survey items measured students' Technology Proficiency (22 items), Technology Use in School (12 items), Technology Use in English Language Arts, Math, Science, and Social Studies (12 items for each subject), Technology Problems (6 items), Small-Group Work (9 items), and School Satisfaction (6 items). Measures of internal consistency for student-level factors range from 0.76 to 0.94.

As a measure of Technology Proficiency, students indicated how well they could use various technology applications on a 5-point scale: 1 (*I can do this not at all or barely)*, 2 (*I can do this with some difficulty*), 3 (*I can do this fairly well*), 4 (*I can do this very well)*, and 5 (*I can do this extremely well*). For measures of Technology Use, Technology Problems, and Small-Group Work, students used a 5-point scale to rate the frequency of activities or interactions: 1 (*never*), 2 (*rarely–e.g., a few times a year),* 3 (*sometimes–e.g.,* *once or twice a month),* 4 (*often*–e.g., *once or twice a week),* and 5 (*almost daily*). Students rated school satisfaction items on a 5-point agreement scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*).

***Style of Learning Inventory*.** Sixth-grade students also completed the Style of Learning Inventory (Metiri Group, 2004). In fall 2004, a total of 4,584 students (82%) completed the SLI as a baseline measure. Respondents included 2,142 treatment (83%) and 2,442 control students (82%). A total of 4,294 students (77%) completed the SLI again in spring 2005, including 2,174 treatment (85%) and 2,120 control students (71%). The SLI is a 48-item survey developed by the Metiri Group and based on a model of self-regulated learning developed by Schunk and Zimmerman in 1998.[2] The items on the SLI are categorized into 12 scales and three groupings. The three grouping and related scales are defined as follows:

- *Forethought* is defined as influential processes and beliefs that precede efforts to learn (goal setting, strategic planning; self-efficacy beliefs; goal orientation; and intrinsic interest),
- *Performance/Volition control* refers to processes that occur during learning efforts and affect concentration and performance (attention focusing, self-instruction, imagery; self-monitoring; and help seeking), and
- *Self-reflection* involves processes that occur after learning efforts and influence a learner's reaction to that experience. Since the learning process is cyclical, these processes will in turn influence forethought regarding subsequent learning efforts (self evaluation, attributions, self reactions, and adaptivity).

Students rated statements regarding their personal self-direction on a 7-point scale, ranging from 1 (*completely false)* to 7 (*completely true)*. A factor analysis of SLI data for sixth graders was conducted in fall. Results revealed very low internal consistency of the SLI scales and groupings. Results showed that none of the groups of items or scales had sufficient reliability, with Cronbach's Alpha scale reliabilities ranging from 0.18 (Attributions) to 0.52 (Goal Setting, Strategic Planning and Help Seeking). Consequently, analyses are limited to the SLI total score, which has a reliability of 0.88.

Campus Technology Inventory. The instructional technology coordinator for each campus completed a Campus Technology Inventor*y* in fall and spring to document the availability of technology. Survey items addressed technology access in the school and classrooms as well as technical and pedagogical support. In both fall and spring, coordinators for 22 immersion and 21 control schools completed inventories.

Observation of Teaching and Learning. Researchers conducted classroom observations in a sample of sixth-grade classrooms (reading/English/language arts, mathematics, social studies, and science). The Observation of Teaching and Learning (OTL) form allows the documentation of basic descriptive information (e.g., number of students, content area),

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[2] Schunk, D., & Zimmerman, B. (1998). *Self-Regulated Learning from Teaching to Self-Reflective Practice.* NY: Gilford Press.

technology access and use (i.e., technology available and used by the teacher and students), and classroom environment (i.e., organization and management). In addition, researchers used time-interval ratings to record information in six areas: class organization (e.g., individual students, pairs, small groups, whole group), teacher activities (e.g., directing, guiding substantive discussion), teacher's technology use (e.g., peripherals, presentation software), student activities (e.g., listening, learning facts, definitions, algorithms), students' technology use (e.g., express themselves in writing, learn/practice skills), and student engagement (rated on a 5-point scale from low engagement to high engagement). Observers made the first rating after observing for 5 minutes, then made a rating every 10 minutes. During the observation, observers also recorded descriptive notes on the lesson objectives, teachers' questioning strategies (lower or higher order), and class activities. Observations typically lasted about 45 minutes.

After the observation, and based on time-interval ratings and descriptive notes, observers rated the intellectual challenge of classroom work. Relying on rubrics developed by Newmann, Wehlage, & Secada (1995), observers rated four dimensions of intellectual challenge on a 5-point scale: Construction of Knowledge—Higher Order Thinking, Disciplined Inquiry—Deep Knowledge, Disciplined Inquiry—Substantive Conversation, and Value Beyond School—Connections to the World Beyond the Classroom. An aggregate score across the four scales is used as an overall measure of the Intellectual Challenge of instruction.

Number of observations. During fall 2004, researchers conducted classroom observations at 22 middle schools (11 treatment and 11 control). In spring, we expanded observations to all 44 of the middle schools. In fall, researchers observed 128 classrooms (64 treatment and 64 control). During spring site visits, we conducted follow up observations, when possible, in the same classrooms. Data collection in spring involved observations in 247 classrooms (124 treatment and 123 control). At small campuses, we observed all sixth-grade core-subject teachers. For larger campuses, we observed at least eight classrooms (about 75% of sixth-grade teachers).

Training for data collection. Prior to fall site visits, researchers participated in a two-day training event. Training activities informed data collectors about the research design, facets of technology immersion, data collection protocols, effective interview and focus group techniques, and classroom observation procedures. Approximately eight hours was devoted to the establishment of inter-rater agreement on the *Observation of Teaching and Learning* (*OTL*) form. During observation training, raters first reviewed background information and individual item and code definitions in the *OTL* manual. Raters next viewed a video in which a classroom teacher used technology as part of a lesson. The trainer stopped raters at 10-minute intervals to record ratings, discuss the extent of agreement or disagreement, and resolve misunderstandings. This process was repeated for an additional classroom video.

To further enhance inter-rater agreement, raters were paired for observations in classrooms during the initial site visit at one immersion and one control school. Following classroom observations, raters again discussed assigned ratings and resolved disagreements. Classroom observations used for training purposes at these middle schools were excluded from statistical analyses. For subsequent site visits to other middle schools, observers were paired for about 25% of classroom observations. Overlapping observations allowed the calculation of observer reliability (i.e., the percentage of exact agreement on ratings from paired observations). Additionally, paired observations supported the use of Many-facets Rasch Analysis (MFRA) to adjust scale scores on the Intellectual Challenge factor (i.e., Higher Order Thinking, Deep Knowledge, Substantive Conversation, Relevance) for the relative difficulty of each scale and the relative severity (or leniency) of each observer.

In spring 2005, an additional one-day training event preceded site visits. The day began with an overview of eTxTIP project activities and a review of available information on individual treatment and control sites (e.g., TEA evaluation reports, technology plans, researcher reflections for fall visits, AEIS reports). Additional activities centered on spring data collection protocols, effective interview and focus group skills, and classroom observation procedures. Approximately half of the day was devoted to improving inter-rater agreement on the *OTL* form. During training, raters again reviewed individual item and code definitions in the *OTL* manual. They next viewed a video in which a classroom teacher used technology as part of the lesson. The trainer stopped raters at 10-minute intervals to record ratings, discuss the extent of agreement or disagreement, and resolve misunderstandings. For subsequent site visits, observers were paired for about 25% of classroom observations. Following observations, raters discussed their level of agreement but did not change assigned ratings. Overlapping observations again allowed the calculation of inter-rater agreement and the use of Multi-faceted Rausch Measurement to adjust for rater leniency or severity on measurement scales.

Inter-rater agreement. We have established inter-rater agreement for the part of the classroom observation instrument that measures Intellectual Challenge. Observers used 5-point rating scales for measures of students' higher-order thinking, disciplined inquiry in the area of deep knowledge, disciplined inquiry in the area of substantive conversation, and connections to the world beyond the classroom (Newmann, Secada, & Wehgle, 1995). Observer reliability on these scales is measured by calculating the percentage of time observers agree on ratings from paired observations. Analyses of observations from fall of 2004 indicate 78% inter-rater agreement across 36 teachers. Agreement reaches 98% when scale categories are allowed to vary by one scale point (on the 5-point scale). We are currently analyzing inter-rater agreement for spring observations.

An overall measure of the Intellectual Challenge of instruction for each teacher was constructed using Many-Facets Rasch Analysis (MFRA). The quality of instruction measure is an aggregate score across the four scales, and is adjusted for the relative difficulty of each scale and the relative severity (or leniency) of each observer. MFRA produces several fit statistics that can be used to measure each observer's intrarater reliability or internal consistency. One of these, observer infit, weights each standardized residual by its variance and is more sensitive to unexpected patterns of small residuals. A second statistic, observer outfit, is an unweighted mean-square residual sensitive to outlying residuals (Linacre, 2004). There is no fixed rule for setting upper and lower limits for theses fit statistics. In some instances “misfitting” raters (observers) have been defined as having either a mean-square infit or outfit statistic greater than 1.5 (Lunz, Wright, & Linacre, 1990). In other cases the range has been from 0.5 to 3.0 (Myford and Wolfe, 2000).

For purposes of this study, we define a “misfitting” observer as one with either a mean-square infit or outfit statistic less than 0.5 or greater than 1.5. This defines “misfit” as less than 50% of the variance in ratings than is modeled (a muted pattern) and more than 50% of the variance than is modeled (a noisy pattern). MFRA analyses of the fall observation data resulted in observer infit values from 0.61 to 1.34 and observer outfit values from 0.62 to 1.20. No unusual rating patterns appeared to be present in the observation data. There do not appear to be unpredicted or overly predictable ratings (Linacre, 1995).

3. Baseline Characteristics of Participating Schools

The use of a quasi-experimental design requires researchers to prove that any detected effects cannot be attributed to pre-existing differences between treatment and control campuses. Thus, relying on our theoretical framework, we have collected extensive baseline data to reveal the characteristics of comparison groups. Results are reported below for measures of school, teacher, and student variables.

School Characteristics

To ensure the comparability of our comparison schools, we have measured school-level variables, including technology access and support services, administrative leadership and system support, classroom technology integration, school culture, and parent and community support.

Technology Access

As one way to understand the existing level of technology in schools, we asked technology coordinators or specialists at each of our sites to complete a Campus Technology Inventory. Information in Table 3.1 shows that in fall 2004 both immersion and control campuses had little technology in their classrooms, with an average of about 2 desktop computers in treatment and control classes. Classrooms in control schools were slightly more likely to have printers, whereas treatment classrooms more often had laptop computers. The greater prevalence of laptops likely reflects the fact that some treatment teachers had received their grant-funded laptops prior to fall data collection. Middle school classrooms seldom had other technology resources, such as Liquid Crystal Display (LCD) projectors, although equipment was often available for checkout in a library or media center. Control campuses had slightly more computer labs and more computers in their labs. Computer labs usually had printers but other technology resources in labs, similar to classrooms, were scarce.

Table 3.1. Campus Technology Inventory (Mean Number)

Items	Immersion *N*=22	Control *N*=21
Instructional classrooms	24.0	21.4
Desktop computers	2.0	2.1
Laptop computers	0.8	0.6
Printers	0.7	1.0
LCD projectors	0.3	0.3
Computer labs	2.1	2.5
Desktop computers	18.0	20.9
Laptop computers	0.1	0.4
Printers	1.1	1.2
LCD projectors	0.3	0.5

Technical and Pedagogical Support

We also asked campus technology leaders to indicate the strength of their agreement with statements regarding the provision of technical and pedagogical support for technology on their campuses. Respondents rated statements on a 5-point scale ranging from (1) *strongly disagree* to (5) *strongly agree*. As a whole, control campuses had slightly stronger technical support for technology at their schools in fall 2004. Technology leaders at control campuses reported more timely hardware and software repairs; greater Internet access and download speeds; and more sufficient professional development. Adequate support for hardware issues appeared to be the greatest problem for all schools.

School Technology

Information on other school technology variables comes from the baseline survey of immersion and control teachers conducted online between September and October 2004. In addition to other areas of interest, teachers responded to items pertaining to their perceptions of school technology. Teachers rated the strength of their agreement with statements on a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). As shown in Table 3.2, five distinct factors emerged.

Table 3.2. Group Differences for School Technology Variables

	Immersion		Control				Effect
Variables	Mean	*SD*	Mean	*SD*	*t*-value	*p*	Size
Leadership and System Support	3.70	0.61	3.59	0.69	3.03	.003*	0.17
Classroom Technology Integration	3.24	0.82	3.23	0.83	0.12	.902	0.01
Technical Support	3.25	0.77	3.26	0.78	-0.33	.739	-0.02
Innovative Culture	3.70	0.67	3.70	0.68	0.02	.984	0.00
Parent and Community Support	3.41	0.82	3.39	0.75	0.37	.710	0.02

Note. Immersion (*n* ranges from 569 to 579 teachers), Control (*n* ranges from 643 to 650 teachers). Scores range from 1 (*strongly disagree*) to 5 (*strongly agree*). *Statistically significant difference.

Comparisons reveal that teachers in both immersion and control schools share similar views on their school's educational technology. Only one statistically significant difference between groups was found, and this difference represented a small effect size (0.17). Teachers on campuses that had received grants for technology immersion were more likely to indicate that their school had stronger Leadership and System Support for technology. For example, teachers were more likely to believe "the principal is an effective leader for technology," "the principal encourages teachers to be innovative and try new methods," and "our school has a well-developed technology plan that guides all technology integration efforts." Since the teacher survey was conducted after middle school campuses received notification about the TIP grant, this may have been a factor in teachers' more positive perceptions of administrative support since campus and district administrators facilitated the grant application process. Alternatively, since administrators in immersion schools took the initiative to apply for grants, they may actually be stronger technology proponents.

Teacher Characteristics

We also have collected extensive baseline data on teacher mediating variables, including technology proficiency and productivity, classroom use of technology by students, and teacher collaboration with colleagues, through surveys of grades 6 through 8 teachers in both immersion and control schools. Comparisons in Table 3.3 reveal that immersion and control teachers have comparable reported levels of technology proficiency. In addition, both groups of teachers use technology with students to a similar extent, and they interact with colleagues in a like manner. Two statistically significant differences between groups were found. Teachers on control campuses reported a higher frequency of technology use for professional productivity. The mean difference and effect size were small, but control teachers were somewhat more likely to report using technology for activities like "keeping administrative records," "communicating with students," and "creating instructional materials." Additionally, teachers on control campuses were more resistant to integrating technology in their instruction. They were more likely to feel that computers are not a necessary part of instruction, using classroom computers is not a priority, and students' use of computers is not practical.

Table 3.3. Group Differences for Teacher Technology-Related Variables

	Immersion		Control				Effect
Variables	Mean	*SD*	Mean	*SD*	*t*-value	*p*	Size
Technology proficiency	4.47	1.52	4.58	1.50	-1.25	.211	-0.07
Professional productivity	2.92	0.75	3.05	0.71	-2.98	.003*	-0.17
Students' technology use	1.85	0.74	1.90	0.72	-1.21	.227	-0.07
Collaboration	2.41	0.74	2.35	0.74	1.43	.152	0.08
Integration							
-Technology Integration	2.98	1.48	2.88	1.41	1.10	.272	0.06
-Learner-Centered Instruction	3.64	1.39	3.65	1.34	-0.16	.873	-0.01
-Resistance to Integration	2.15	1.20	2.45	1.33	-4.16	.000*	-0.24

Notes. Immersion (*n* ranges from 588 to 603 teachers), Control (*n* ranges from 665 to 685 teachers). collaboration. *Statistically significant difference.
[a] Items rated on a 7-point scale: 1 (*not true of me now*) to 7 (*very true of me now*).
[b] Items rated on a 5-point frequency scale: 1 (*never*) to 5 (*almost daily*).

Student Characteristics

It was also important to determine whether differences existed between our sixth-grade students at immersion and control campuses, so our student survey measured a number of technology-related variables. Comparisons in Table 3.4 show that both immersed and control students reported comparable levels of technology proficiency with a variety of technology applications.

Table 3.4. Group Differences for Student Technology-Related Variables

Variables	Immersion		Control				Effect
	Mean	*SD*	Mean	*SD*	*t*-value	*p*	Size
Self-Directed Learning	4.63	0.73	4.55	0.75	-3.84	.000*	0.11
Technology Proficiency	2.81	0.92	2.85	0.90	1.73	.084	-0.04
Technology Use in School	2.05	0.82	2.05	0.79	-014	.891	0.00
Use in ELA	1.97	0.84	1.92	0.78	-1.21	.228	0.06
Use in math	1.82	0.85	1.78	0.80	-0.73	.468	0.05
Use in science	1.88	0.85	1.90	0.82	0.39	.700	-0.02
Use in social studies	1.80	0.85	1.95	0.92	2.72	.007*	-0.17
Technical Problems	2.19	0.96	2.24	0.96	1.12	.265	-0.05
Small-Group Work[c]	2.72	0.90	2.84	0.90	4.50	.000*	-0.13
Satisfaction with School[d]	3.74	0.74	3.73	0.75	-0.20	.839	0.01

Note. Immersion (*n* ranges from 825 to 2,186 sixth-grade students), Control (*n* ranges from 908 to 2,391 sixth-grade students). Scores range from 1 (*completely false*) to 7 (*completely true*) for the self-directed learning, from 1 (*I can do this not at all or barely*) to 5 (*I can do this extremely well*) for technology proficiency, from 1 (*never*) to 5 (*almost daily*) for technology use, small group work, and technology use in subject-specific classes, from 1 (*never*) to 5 (*almost always*) for technology problems, and from 1 (*strongly disagree*) to 5 (*strongly agree*) for student satisfaction with school.
*Statistically significant difference.

Both groups of students also reported similar frequency of technology use across school and core-content classes. Likewise, levels of reported technology problems and satisfaction with school were similar for both immersed and control students. Three statistically significant differences between groups were found. Students on immersed campuses reported higher levels of self-directed learning. Students on control campuses more frequently reported working with other students in small groups, and using technology in social studies classes. In all three cases, the mean differences and effect sizes were small.

In sum, overall evidence from baseline data collected in fall 2004 suggests that the selection of control campuses by matching on key variables was effective in creating a comparable comparison group. Immersion and control schools are reasonably well matched on a number of important school, teacher, and student variables. Although a few statistically significant differences between groups have been identified, effect sizes for those differences are generally small, and significant differences are often due to large sample sizes. The collection of baseline data on an array of mediating and outcome variables from the study's theoretical framework has provided a thorough understanding of existing conditions in schools. This information will be invaluable in analyzing and interpreting data collected subsequently.

4. Technology Immersion—First-Year Implementation

Findings presented below first describe the nature of technology immersion and efforts undertaken to operationally define the treatment and ensure more consistent implementation across sites. Next, we offer insights on first-year implementation. Findings come from analyses of qualitative and quantitative data collected during the school year.

Defining Technology Immersion

To ensure consistent interpretation of technology immersion and comparability across sites, the TEA issued a Request for Qualifications (RFQ) that allowed the vendor community to apply to become providers of *Technology Immersion* packages. Although state statute provided a general description of technology immersion, the concept had to be defined operationally to ensure consistent implementation. To that end, successful applicants to the RFQ had to have the following six components in their plan:

- A wireless mobile computing device for each educator and student on an immersed campus to ensure on-demand access to technology;
- Productivity, communication, and presentation software for use as a learning tool;
- Online instructional resources that support the state curriculum in English language arts, mathematics, science, and social studies;
- Online assessment tools to diagnose students' strengths and weaknesses or to assess their progress in mastery of the core curriculum;
- Professional development for teachers to help them integrate technology into teaching, learning, and the curriculum; and
- Initial and ongoing technical support for all parts of the package.

Through a competitive process, the TEA selected three lead vendors as providers of technology immersion packages (Dell Computer Inc., Apple Computer Inc., and Region 1 Education Service Center [ESC]). Table 4.1 provides an overview of the basic components within each package and the individual vendors that provide various components. Prices for technology immersion packages varied according to the numbers of students and teachers, the type of laptop computer, and the vendor package. Package costs ranged from about $1,100 to $1,600 per student. Of the 22 immersion sites, 6 middle schools selected the Apple package, 15 selected the Dell package, and 1 school selected the Region 1 ESC package (Dell)

Table 4.1. Technology Immersion Packages

	Apple *N*=6 Schools	Dell *N*=15 Schools	Region 1 ESC *N*=1 School
Wireless laptop computer	Apple iBook G4	Dell Inspiron or Latitute	Dell Inspiron
Productivity software	Apple-Works	MS Office eChalk	MS Office eChalk
Online resources	Various	Various	Various
Online assessment	*Assessment Master*	*i-Know*	*i-Know*
Professional development	Apple Model	Co-nect	Classroom Connect
Technical and pedagogical support	Apple Campus	Dell Campus	ESC 1 Campus

Wireless Laptops and Productivity Software

All vendors offered a wireless laptop as the mobile computing device. Campuses could select either Apple laptops (iBook and MAC OSX) or Dell laptops (Inspiron or Latitude with Windows OS). For Apple laptops, *AppleWorks* provides a comprehensive suite of productivity tools, including Keynote presentation software, Internet Explorer, Apple Mail, iCal calendars, iChat instant messaging, and iLife Digital Media Suite (iMovie, iPhoto, iTunes, GarageBand, and iDVD). For Dell laptops, *Microsoft Office* includes Word, Excel, Outlook, PowerPoint, and Access. In addition, *eChalk* serves as a “portal” to other web-based applications and resources included in the immersion package and student-safe email solution. Region 1 ESC offered either Apple or Dell products.

Online Instructional and Assessment Resources

Immersion packages also include a variety of online resources. Apple included the following online resources: *netTrekker* (an academic Internet search engine), *Beyond Books* from Apex Learning (reading, science, and social studies online), *ClassTools Math* from Apex Learning (complete math instruction), *ExploreLearning Math and Science* (supplemental math/science curriculum), *KidBiz3000* from Achieve 3000 (differentiated reading instruction), and *My Access Writing* from Vantage Learning (support for writing proficiency). Dell, Inc. selected *netTrekker* (an academic Internet search engine) and *Connected Tech* from Classroom Connect (technology-based lessons and projects). Region 1 ESC selected *Connected Tech* but also added a variety of teaching and learning resources including *Unitedstreaming* (digital videos), *Encyclopedia Britannica*, *EBSCO* (databases), *NewsBank*, and *K12 Teaching and Learning Center*.

For the Apple package, *AssessmsentMaster* (Renaissance Learning) provides a formative assessment in all four core subject areas. Both the Dell and Region 1 ESC packages include *i-Know* (CTB McGraw Hill) for core-subject area assessment. In addition, all campuses have access to the online Texas Mathematics Diagnostic System that is provided free of charge by the state.

Professional Development

Each immersion package includes a different professional development provider. Apple uses its own professional development model, whereas the Dell package relies on *Co-nect* (a commercial provider) to support professional development. Region 1 ESC uses a combination of service center support plus other services offered through *Connected Coaching and Connected University.* Although the professional development models and providers differ, they all include some common required elements, such as support immersion package components, the design of technology-enhanced learning environments and experiences, lesson development in the core subject areas, sustained learning opportunities, and ongoing coaching and support. Individual districts and campuses must collaborate with vendors to develop their own professional development plans for teachers and other staff.

Technical and Pedagogical Support

Each technology immersion package provider also is required to provide campus-based technical support to advance the effective use of technology for teaching and learning. Apple designed a Master Service and Support Program that leveraged its broad-based experience in one-to-one projects. Dell established a Call Center dedicated to technical support for TIP grantees as well as an 800 telephone number for hardware and software support. Region 1 ESC has an online and telephone HelpDesk to answer questions and provide assistance.

In sum, the TIP project is unique in its use of competitive grant funds to test the effectiveness of a specifically defined educational intervention. The RFQ process allowed the creation of technology immersion packages with common elements. Although the "treatment" is not identical across sites, the specification of a comprehensive technology intervention with specific components represents a major accomplishment in Texas. Still, the complex nature of the treatment makes it even more important for researchers to be able to gauge how and how well the immersion packages are implemented in order to explain any differences in outcomes that may emerge.

Measuring Implementation Fidelity

The implementation of any program involves a process of adapting the "ideal" program to the local conditions and organizational dynamics. Even well conceived programs must progress through stages from initial struggles to get the program "off the ground" to full implementation. Consequently, any evaluation must assess progress toward the implementation of the core program components that are undertaken to achieve intended goals and outcomes.

For the technology immersion project, researchers have collected extensive data on the nature of immersion. Scoring rubrics have been developed for domains and elements that have been identified through a review of the Technology Immersion packages. We have identified four levels of immersion: *Minimal Immersion* (1), *Partial Immersion* (2), *Substantial Immersion* (3), and *Full Immersion* (4). Additionally, we have measured the quality of specific domains and elements within those domains. For example, the *Technology Access* domain includes *student laptop access* (the number of days students had laptops in the first year) and *student home access* (the extent to which students could use laptops outside of school).

The overall level of *Technology Immersion* is a composite score derived from the four domain scores: (a) *Technology Access*, (b) *Technical and Pedagogical Support*, (c) *Professional Development*, and (d) *Educational Resources*. Scores are based on both quantitative and qualitative data from multiple sources. We have analyzing data from vendor records, interviews, focus groups, surveys, and grant evaluation documents.

Technology access. Access to technology is measured by the nature and extent of student access to laptop computers. Since "laptop rollout" has varied by school and occurred at various time points during the year, we have determined the number of days that students had laptops during the school year. Since on some campuses school policies, insurance issues, and parent refusals to accept liability have affected student' access to laptops both at school and at home, we have also gauged the extent to which students had access to laptops outside of school. In addition, we have used information from student surveys to assess the extent to which students have opportunities to use specific technology applications in their core-subject classrooms (e.g., use a word processor to write a story or report or use software to learn and practice skills) and the frequency with which teachers have students use technology in reading/English language arts, mathematics, science, and social studies classes.

Technical and pedagogical support. The provision of technical and pedagogical support for immersion by vendors and campus-level staff is a grant requirement. Accordingly, scoring rubrics have been developed to measure technical support staffing, the extent of campus technical problems, the availability of classroom mentoring and coaching for teachers, and the level of teacher collegial support for immersion. Information for ratings come from interviews with campus principals and technology leaders and through teacher survey items.

Professional development. In constructing measures of TIP professional development, we draw from research conducted on the effectiveness of the Eisenhower Professional Development Program (e.g., Garet, Porter, Desimone, Birman, & Yoon, 2001). Key features of quality professional development provide a framework for examining dimensions of TIP vendors' professional development models. We have adapted the dimensions to align with our project objectives and approaches. First, we measured the duration of activities as the total number of *contact hours* teachers spend in professional development and the period of time in days, weeks, or months over which the activity was spread (*time span*). In addition, we assessed the extent to which all teachers on immersed campuses participated in available professional development opportunities. Based on teacher survey data, we estimated *collective participation* (the percentage of teachers at each campus participating in 17 or more hours of professional development). TIP professional development models also were required to include a classroom support component, so we measured the *classroom connection* as the percentage of teachers involved in modeling, coaching or mentoring. Data for professional development measures come from online professional development logs submitted by districts to the TEA during the 2004-05 school year, documents provided by vendors, and professional development items included on teacher surveys.

Resources. Our most challenging task was the determination of the extent to which teachers and students utilized the online curricular resources, online assessments, and productivity software provided within each vendor package. We have used several data sources to assess resource availability and use, including electronic usage documents provided by vendors, teacher and student surveys of technology use, and focus groups with students and teachers.

Progress Toward Immersion

Findings in Figure 4.1 illustrate the progress of the 22 middle schools toward technology immersion. Growth is measured on a 4-point scale (*minimal, partial, substantial, and full immersion)* across four domains (*technology access, technical and pedagogical support, professional development, and curricular resources*). Results suggest that districts and campuses have made strides toward immersion in the first year, but the level of implementation varies by campus and no middle school has achieved *full immersion*. The majority of campuses have achieved only *partial immersion*.

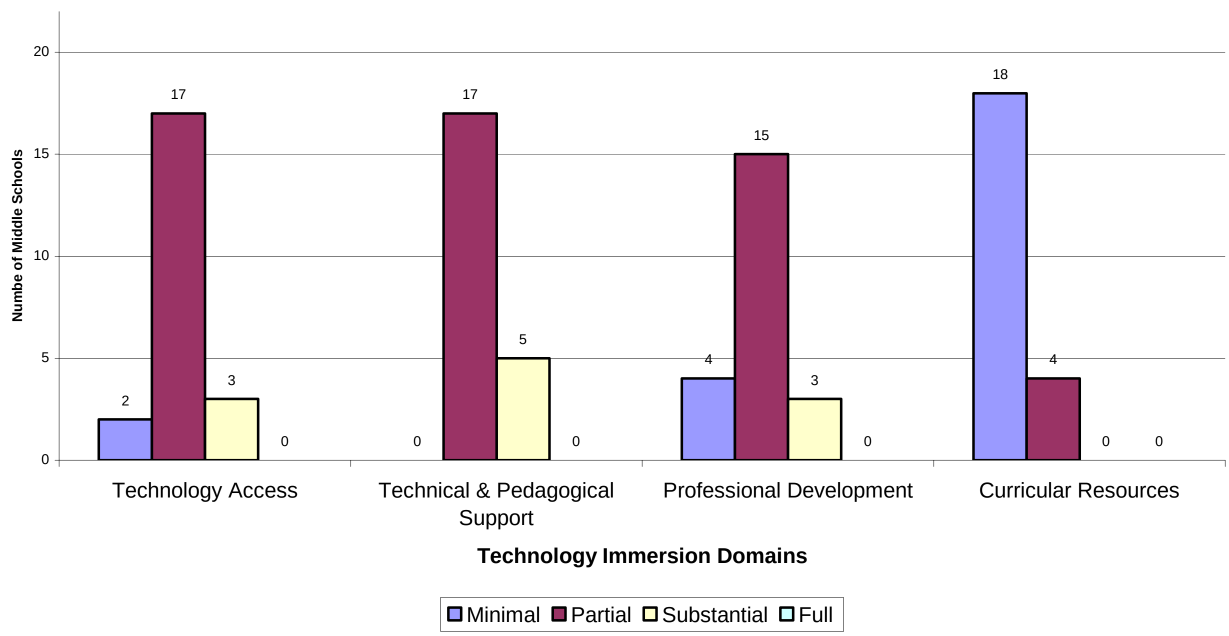

Figure 4.1. First-year progress toward technology immersion by domain.

Technology Access

Due to logistical procedures in the awarding of two rounds of grant funds, most of the campuses had a late start. Teachers for the most part did not receive their laptops until late September through early December 2004. Student laptop “rollout” was delayed even more. About half of the 22 campuses distributed laptops to students during the first semester of the school year, with rollouts occurring during October, November, and December 2004. The remainder of campuses distributed laptops to students in January and February 2005.

Due to delays in laptop rollout, the amount of time students had their laptops varied by campus, with many students having less than four months of laptop access. The number of days that students had laptops at campuses ranged from 72 to 144 days out of a 180-day school year. Additionally, student access outside of the school varied. While students at 14 campuses were allowed to take laptops home, 6 campuses did not allow students to use laptops outside of the school, and 2 campuses restricted student use to only special assignments. Additionally, in the first year of implementation, students' opportunity to use their laptops for learning in core subject areas was limited.

Technical and Pedagogical Support

A key aspect of this project has been the dedication of support for the implementation of technology immersion. Although the type and extent of support varies by campus, extensive grant and local resources have been invested in providing assistance to teachers and students in using technology. Even so, the extent of available staff and their level of expertise vary. Some campuses have fully capable technical support staff who can alleviate problems while other campuses have little or limited access to support staff capable of assisting and completing installations and repairs. Consequently, some teachers report substantial problems with equipment, Internet access, and waits for repairs, whereas on other campuses, teachers have fewer problems. The availability of coaching or mentoring from an internal source, such as another teacher or technology coordinator also varies. Typically, about half or more of core-subject teachers received coaching *sometimes*. Similarly, teachers expressed differing levels of support from their colleagues. On some campuses, teachers interacted less frequently to discuss instructional strategies for integrating technology or to exchange feedback on their lessons and student work.

Professional Development

All districts and campuses provided professional development for teachers and staff during the first year. The extent and type of professional development, however, varied according to the particular vendor that provided training, the number of days allocated by each campus for professional development, and the extent of teacher participation in available opportunities. Our analyses of professional development generally indicated only *partial immersion*. Teachers at campuses typically indicated participation in less than three days of technology-related professional development, and for some schools, professional development was spread over about four months rather than the entire school year. Moreover, on many campuses, technology-related professional development involved some teachers but not all or even almost all. In the first year, a substantial portion of core-subject teachers on many campuses reported that they *never* or *rarely* received coaching or mentoring from an external source, while on other campuses, a greater proportion of teachers received classroom support for technology integration.

Educational Resources

The vendor packages included a wealth of instructional resources and assessments. One of the challenges in the first year was acquainting teachers with the available resources. Although most teachers were introduced to the resources and took first steps toward using at least some of the resources during the initial year, overall resource use was sporadic. Technology immersion places great demands on teachers. Many teachers were "overwhelmed" in trying to learn how to use the new technology as well as learning how to infuse new resources into the existing curriculum. Teachers spoke frequently of their need for more time to explore resources and to determine how to use them in their subject area. Thus, it is not surprising that at most middle schools the level of implementation of the curricular resources was rated as *minimal immersion.*

Implementation Challenges

Research studies and practical wisdom reveal that change takes time and is a process of growth (e.g., Senge, 1999). Understanding the process and challenges that limit progress, however, helps to nurture continued progress. Some of the challenges encountered in technology immersion during the initial year included the following:

- **Insufficient planning.** Since many districts and campuses had a late start (i.e., RFA process, funding), planning and project initiation occurred "on the fly." Understandably, this has undermined implementation.
- **Outdated infrastructure.** Outdated school infrastructure and technical issues have impeded progress on many campuses. Districts have invested substantial local resources on unanticipated costs such as building infrastructure to support wireless technology.
- **Teacher readiness and receptivity.** Teacher attitude, understanding of immersion, technology knowledge and skills, classroom management, and propensity toward technology use vary substantially by classroom and school.
- **Inconsistent policies and practices.** Policies and practices related to laptop access and use vary by district (e.g., Internet access at home, access to games and email, disciplinary infractions).
- **Inconsistent professional development.** The extent and type of professional development varies across schools and for individual teachers within schools.
- **Pressure to improve TAKS scores.** Pressure to improve TAKS scores impedes change as teachers often attempt to maintain the "status quo" rather than try new and untested methods and materials.
- **Leadership.** The extent and continuity of leadership varies by district and campus (see description below).

Although not addressed specifically in the immersion package, leadership emerges as a critical factor contributing to and explaining the level of implementation. Factors that appeared to affect implementation fidelity included leadership instability, the level of leadership commitment to the project, the creation of a strong leadership team, and the level of vendor support. First, *leadership instability* was an issue. At some immersion campuses, principals were on leave for several months, while on other campuses principals resigned and were replaced by interim principals. In other instances, principals announced that they would be leaving at the end of the school year, so teachers anticipated a leadership change. Additionally, in several districts, superintendents resigned and were replaced by interim superintendents or new superintendents who were not involved in the grant application process.

The level of *administrative commitment* to full implementation of technology immersion also varies. In some districts and campuses, this project is a high priority and is receiving strong financial and policy support at all levels of the educational system (superintendent, district leaders, and campus leaders). For example, in some smaller districts, superintendents recognize that technology immersion is the direction of the future, so they are directly involved in planning and visit the middle schools on a regular basis. This “hands-on” administrative involvement communicates expectations for success to campus leaders, teachers, and students. In larger districts, superintendents are less likely to be directly involved, but in some cases, a well connected central administrator plays a key role in establishing expectations for the project.

Districts and campuses that appear to be making headway in immersing middle schools in technology have created a *leadership team* with key roles and responsibilities. Effective teams typically include at least one central administrator, a principal, and a campus specialist (technology and/or instructional). Although teachers are frequently consulted on project activities, they are less likely to be part of the formal decision-making team. Leadership from *vendors* is also important. In some cases, vendors are cited as key participants in planning, decision making, and problem solving.

In sum, the level of implementation of technology immersion components is an important consideration in the interpretation of first-year effects. Overall findings on campuses’ progress around various immersion components suggests that, at the end of the first year, overall campus implementation is most frequently considered *minimal* or *partial* rather than *substantial* or *full*.

5. Effects of Technology Immersion on Schools and Teachers

In the theoretical framework, researchers posited that given quality implementation of immersion (i.e., robust wireless technology access, effective use of online curricular and assessment resources, professional development that supports curricular integration, and adequate technical and pedagogical support to maintain an immersed campus), one might expect school-level improvements in measures of classroom technology integration, innovative culture, technical support, and parent and community support. Leadership and system support undergirds progress toward immersion.

This improved school environment should in turn lead to teachers who have greater technology proficiency, use technology more for their own professional productivity, and collaborate more with their peers. Moreover, teachers in immersed schools will have students use technology more in their classrooms, and they will use laptops as a tool to increase the intellectual challenge and relevance of lessons.

Findings on the effects of technology immersion on various school- and teacher-mediating variables come from an online survey of teachers completed in fall 2004 (September to October) and again in spring of 2005 (April to May). Teachers responded to items pertaining to their perceptions of school technology and their own personal and classroom experiences with technology. In fall, 1,271 teachers completed the survey (97% of grades 6-8 teachers, 97% of immersed teachers, and 98% of control teachers). In spring, 1,144 teachers (88% of all teachers, 87% of immersed teachers, and 88% of control teachers) completed the survey. Additionally, researchers conducted classroom observations in a sample of sixth-grade core-subject classrooms in fall (64 treatment teachers and 64 control) and again in spring (124 treatment teachers and 123 control) to gather information on instructional practices and changes across time.

School and Teacher Mediating Variables—HLM Analysis

On one part of surveys, teachers responded to items pertaining to their perceptions of school-level technology variables. Teachers were asked to rate the strength of their agreement with statements on a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Five distinct factors emerged from a factor analysis: Leadership and System Support (12 items), Classroom Technology Integration (4 items), Technical Support (5 items), Innovative Culture (4 items), and Parent and Community Support (2 items). Measures of internal consistency for the school-level factors ranged from acceptable (0.67) to excellent (0.91).

The teacher surveys also collected data on teacher mediating variables. First, for Technology Proficiency, teachers rated their skills in using various technology applications on a 7-point scale: 1 and 2 (*not true of me now*); 3, 4, and 5 (*somewhat true of me now*); and 6 and 7 (*very true of me now*). Teachers also rated the frequency with which they use technology for Professional Productivity (administrative and instructional tasks) on a 5-point scale: 1 (*never*), 2 (*rarely: a few times a year)*, 3 (*sometimes: once or twice a month*), 4 (*often: once or twice a* *week*), and 5 (*almost daily*). Likewise, teachers rated the frequency of their Students' Use of Technology and Collaboration (with colleagues) on the 5-point frequency scale.

In addition, teachers responded to items measuring technology integration on a 7-point scale, ranging from 1 (*not true of me now*) to 7 (*very true of me now*). Confirmatory factor analysis of these items, which were adapted from the Levels of Technology Implementation (LoTi) Questionnaire (Moersch, 2001), showed reasonable fit indices for a model having Technology Integration, Learner-Centered Instruction, and Resistance to Integration as latent variables. Measures of internal consistency for all of the teacher-level variables ranged from 0.70 (the 3-item Resistance to Integration scale) to 0.97 (the 27-item Technology Proficiency scale). (See technical appendix for details.)

The analyses that follow contrast immersion and control teachers before and after one school year of the implementation of the Technology Immersion Pilot project. Immersion effects are estimated for each of the scales described above. We analyzed the effects of immersion on teachers' perceptions of technology and self-reported proficiencies using a two-level hierarchical linear model (HLM).[1]

Teacher-Level Model

In the teacher-level model, spring 2005 survey scale scores were regressed on fall 2004 scale scores, teaching experience in years, technology certification status[2] (0 if not certified, 1 if certified), and gender (0 if male, 1 if female). That is,

$$Y_{ij} = \beta_{0j} + \beta_{1j}(Fall\ 2004\ scale\ score) + \beta_{2j}(Teaching\ experience) + \beta 3_j(Teacher\ certification) + \beta 4_j(Gender) + r_{ij}.$$

With all 2005 survey scales, significant variation was found across middle schools (a justification for using HLM; see the intraclass correlations in Tables 5.3 and 5.5). Thus, the school means (β_{0j}) were specified as randomly varying. The coefficients for fall 2004 scale score (β_{1j}) were specified as fixed unless the reduction in the deviance statistic (significant chi square) with the more complex model justified a random specification. The coefficients for experience, gender, and certification status were specified as fixed.

[1] HLM was used for data analysis because teachers are clustered within middle schools. As a result, because of selection processes (e.g., schools may attract similar types of teachers) and shared common backgrounds, teachers within schools are more similar to each other than are teachers from different schools. Consequently, measures within schools may not be independent, and may be more highly correlated than measures of teachers from different schools. (Note that when a clustering effect is absent, there is no need to utilize HLM.) Ignoring this clustering results in aggregation bias and misestimated (mostly underestimated) standard errors. However, hierarchical linear modeling makes no assumption about independence, and it estimates the degree of clustering of measures and uses this estimate in the calculation of the precision with which treatment effects are estimated (Raudenbush & Bryk, 2002).

[2] Texas technology certificates include Technology Applications 8-12, Computer Science 8-12, and Master Technology Teacher.

School-Level Model

A school-level model was developed to answer the question of whether immersed schools had higher scale scores than control schools, after controlling for initial scale scores and experience, gender, and certification status. That is,

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(Immersion\ dummy) + \mu_{0j}.$$

The immersion dummy was an indicator variable with a value of 1 for an immersed school and a value of 0 for a control school.

Effects of Immersion on Schools

Data from analyses of school variables are summarized in Table 5.1. Additional statistical details for the HLM models are reported in Tables 5.2 and 5.3 for school-level scales. Summary results in Table 5.1 show that technology immersion had a statistically significant effect on teachers' perceptions of four of the five school-level technology variables. For three scales, the size of the effect (extent to which the phenomenon exists) was moderate to large. After controlling for fall 2004 scale scores, teacher experience, technology certification status, and gender, there were no significant differences in the spring 2005 scores of teachers in immersed schools and teachers in control schools on the Technical Support scale. Even so, teachers in treatment schools were more likely to report that "most of our school computers are kept in good working condition" and "my requests for technical assistance are addressed in a timely manner."

Table 5.1. Immersion Effects on School Technology

School-Level Scales	Immersion Effect Net of Fall Score, Teacher Experience, Gender, & Certfication Status	Magnitude of Effect in Standard Deviation Units[a]
Leadership and System Support	Yes	0.20 (small)
Classroom Technology Integration	Yes	0.56 (large)
Technical Support	No	--
Innovative Culture	Yes	0.35 (moderate)
Parent and Community Support	Yes	0.49 (moderate)

Source: Online teacher surveys conducted in fall 2004 and spring 2005
Note. The interpretation is that anything greater than 0.5 is large, 0.5-0.3 is moderate, 0.3-0.1 is small, and anything smaller than 0.1 is trivial.

For other school-level variables, after controlling for fall 2004 school-level scale scores, teacher experience, certification status, and gender, teachers in immersed schools had higher scale scores than teachers in control schools on:

- Leadership and System Support (0.12 points, 0.20 standard deviation units),
- Classroom Technology Integration (0.44 points, 0.56 standard deviation units),
- Collegial, Innovative Culture (0.23 points, 0.35 standard deviation units), and
- Parent and Community Support (0.37 points, 0.49 standard deviation units).

Table 5.2. Immersion (Fixed) Effect Analyses of School-Level Scales

School-Level Scale	School-Level Analysis	Gamma Coefficient	Standard Error	*t*
Leadership and System Support[a]				
	Base	3.405	0.112	30.28***
	Fall score	0.665	0.039	17.01***
	Experience (pooled)	0.002	0.001	1.34
	Certification status	0.213	0.102	2.09*
	Gender	0.042	0.020	1.63
	Immersion dummy	0.138	0.051	2.70*
Classroom Technology Integration[a]				
	Base	3.150	0.156	20.25***
	Fall score (pooled)	0.528	0.032	16.66***
	Experience (pooled)	-0.004	0.002	-1.95
	Certification status	0.163	0.145	1.12
	Gender	0.112	0.044	2.58*
	Immersion dummy	0.444	0.065	6.78***
Technical Support[a]				
	Base	3.037	0.192	15.79***
	Fall score	0.467	0.034	13.57***
	Experience (pooled)	0.002	0.002	1.11
	Certification status	0.397	0.187	2.13*
	Gender	0.025	0.054	0.46
	Immersion dummy	0.145	0.079	1.85
Collegial, Innovative Culture[a]				
	Base	3.660	0.150	24.02***
	Fall score	0.493	0.039	12.48***
	Experience (pooled)	0.005	0.001	3.64*
	Certification status	0.081	0.141	0.57
	Gender	0.113	0.041	2.73**
	Immersion dummy	0.225	0.049	4.56***
Parent, Community Support[a]				
	Base	3.017	0.158	19.12***
	Fall score (pooled)	0.435	0.038	11.57***
	Experience (pooled)	0.002	0.002	0.86
	Certification status	0.263	0.155	1.69
	Gender	0.138	0.043	3.22**
	Immersion dummy	0.374	0.050	7.51***

*$p < .05$; **$p < .01$; ***$p < .001$.
[a] Items rated on a 5-point scale.

Teachers' responses to individual scale items help to explain the positive effects of immersion on school mediating variables.

Leadership and system support. Control teachers' ratings of their schools' support for technology remained virtually the same from fall to spring. In contrast, teachers in immersed schools rated administrative leadership and support higher on each of the scale items. The greatest differences between teachers centered on expectations, planning, leadership, and support for technology. Treatment teachers were far more likely than control teachers to believe:

- In this school, there are clear expectations that technology will be used to enhance student learning ($M = 4.2$ on the 5-point scale, +0.5 points),

- Teachers receive adequate administrative support to integrate technology into classroom practice (*M* = 4.0, +0.4 points),
- The principal is an effective leader for instructional technology (*M* = 3.8, +0.4 points), and
- Our school has a well-developed technology plan that guides all technology integration efforts (*M* = 3.7, +0.4 points)

Classroom Technology Integration. This scale reflected the extent to which the school provided adequate classroom technology resources and sufficient training to use technology for instruction, and accordingly, the extent to which teachers' used technology to address student technology standards, assess student performance, and plan instruction. As expected, immersed and control teachers' responses differed most on items related to technology resources:

- Students have adequate access to technology resources in my classroom (*M* = 3.6, +1.0 points), and
- I incorporate the TEKS for student technology applications into my content area (*M* = 4.1, +0.4 points).

Surprisingly, considering the professional development component of immersion, there was only a small difference between teachers in their belief that, "I have received sufficient training to incorporate technology into my instruction" (*M* = 3.7 for treatment teachers and *M* = 3.5 for control). Responses may reflect immersion teachers' increasing awareness of the challenges encountered in integrating classroom technology.

Innovative Culture. This scale intended to capture teachers' shared understanding of technology, receptivity to technology, and propensity for innovative practices. Although teachers in immersed schools rated each of the items higher than control teachers, the largest differences suggested that treatment teachers were more likely to:

- share an understanding about how technology will be used to enhance learning (*M* = 3.9, +0.4 points) and
- be unafraid to learn about new technologies and use them with their classes (*M* = 3.9, +0.3 points).

Parent and Community Support. The higher scores for teachers in immersed schools on items related to parent support for the school's emphasis on technology (*M* = 3.8, +0.5 points) and active support from the community for instructional efforts with technology (*M* = 3.7, +0.3 points) appear to be reflect the strength of parent and community connections built through the implementation of one-to-one technology.

Effects of Immersion on Teachers

For teacher-level measures, results were universally positive (see Tables 5.3 and 5.4). Technology immersion had a statistically significant effect on teachers' self-reported ratings of six teacher-level technology variables. Effect sizes were typically moderate to large, with the greatest impact of immersion on teachers' integration of technology in their classes and their students' use of technology in the classroom. For one variable, Resistance to Integration, teachers in immersed schools reported lower levels of resistance than teachers in control schools, but differences were statistically insignificant.

After controlling for fall 2004 teacher-level scale scores and teacher experience, technology certification status, and gender, teachers in immersed schools scored higher than teachers in control schools on:

- Technology Proficiency (0.22 points, 0.16 standard deviation units),
- Professional Productivity (0.27 points, 0.37 standard deviation units),
- Student's Use of Technology (0.57 points, 0.70 standard deviation units),
- Collaboration (0.32 points, 0.41 standard deviation units),
- Technology Integration (1.12 points, 0.73 standard deviation units), and
- Learner-Centered Instruction (0.41 points, 0.30 standard deviation units).

Table 5.3. Immersion Effects on Teacher Variables

Scale and Type	Immersion Effect Net of Fall Score, Teacher Experience, Gender, & Certfication Status	Magnitude of Effect in Standard Deviation Units[a]
Technology Proficiency	Yes	0.16 (small)
Professional Productivity	Yes	0.37 (moderate)
Student's Use of Technology	Yes	0.70 (large)
Integration		
Technology Integration	Yes	0.73 (large)
Learner-Centered Instruction	Yes	0.30 (moderate)
Resistance to Integration	No	0.16 (small)
Collaboration	Yes	0.41 (moderate)

Source: Online teacher surveys conducted in fall 2004 and spring 2005.
Note. The interpretation is that anything greater than 0.5 is large, 0.5-0.3 is moderate, 0.3-0.1 is small, and anything smaller than 0.1 is trivial.

Table 5.4. Immersion (Fixed) Effect Analyses of Teacher-Level Variables

School-Level Scale	School-Level Analysis	Gamma Coefficient	Standard Error	*t*
Technology Proficiency				
	Base	666	0.211	22.16***
	Fall score (pooled)	0.753	0.01	38.71***
	Experience (pooled)	-0.007	0.003	-2.13*
	Certification status	0.016	0.206	0.08
	Gender	0.124	0.055	2.25*
	Immersion dummy	0.222	0.071	3.12**
Professional Productivity				
	Base	3.018	0.117	25.90***
	Fall score (pooled)	0.692	0.032	21.90***
	Experience (pooled)	-0.003	0.002	-1.64
	Certification status	-0.002	0.103	-0.02
	Gender	0.087	0.039	2.24*
	Immersion dummy	0.273	0.043	6.35***
Student's Use of Technology				
	Base	1.708	0.154	11.12***
	Fall score (pooled)	0.653	0.026	25.22***
	Experience (pooled)	-0.006	0.002	-2.95**
	Certification status	0.224	0.143	1.57
	Gender	0.046	0.042	1.09
	Immersion dummy	0.573	0.063	9.09***
Technology Integration				
	Base	2.424	0.185	13.08***
	Fall score (pooled)	0.648	0.031	20.68***
	Experience (pooled)	-0.012	0.003	-3.56**
	Certification status	0.592	0.152	3.89***
	Gender	0.291	0.071	4.08***
	Immersion dummy	1.115	0.134	8.35***
Learner Centered Instruction				
	Base	3.010	0.270	11.15***
	Fall score (pooled)	0.527	0.027	19.25***
	Experience (pooled)	-0.007	0.004	-1.94
	Certification status	0.602	0.246	2.45*
	Gender	0.261	0.088	2.96**
	Immersion dummy	0.407	0.083	4.90***
Resistance to Integration				
	Base	2.407	0.269	8.95***
	Fall score	0.497	0.041	12.07***
	Experience (pooled)	0.004	0.004	0.92
	Certification status	0.145	0.258	0.56
	Gender	-0.249	0.085	-2.95**
Collaboration				
	Base	2.042	0.161	12.66***
	Fall score (pooled)	0.595	0.025	23.93***
	Experience (pooled)	-0.002	0.002	-1.07
	Certification status	0.314	0.158	1.98*
	Gender	0.063	0.043	1.46
	Immersion dummy	0.321	0.056	5.69***
	Immersion dummy	-0.207	0.081	-2.54*

*$p < .05$; **$p < .01$; ***$p < .001$.

Technology Proficiency. Interestingly, in spring 2005, there was little difference between teachers in immersed and control schools on items measuring technology operations (e.g., send email to coworkers, parents, or peers; search for and find a Web site; find primary sources of information on the Internet). Teachers also reported the highest levels of proficiency in these types of skills (5 to 6 on the 7-point scale). The strongest divergence between groups was treatment teachers' higher self-reported ratings on items related to classroom instruction. For example, treatment teachers reported an enhanced ability to:

- use the computer to create a slideshow presentation (*M* = 5.6, +0.3 points),
- teach my students about copyright issues as the relate to the Internet (*M* = 4.9, +0.3 points),
- create a lesson plan or unit that incorporates subject matter software as an integral part (*M* = 4.8, +0.3 points),
- use technology to collaborate with other colleagues who are distant from my classroom (*M* = 4.8, +0.3 points), and
- describe five software programs that I would select and use in my teaching (*M* = 4.4, +0.3 points).

Professional Productivity. This scale measured the frequency of teachers' use of technology for administrative and classroom management, communication, information gathering, assessment, and instructional purposes. In spring, there were substantial differences between teacher groups in some key areas. Treatment teachers used technology far more often than control teachers to:

- communicate with students (*M* = 3.3 on the 5-point scale, +0.8 points),
- post homework, class requirements, or project information on a website (*M* = 2.9, +0.7 points),
- administer online assessments, (*M* = 2.4, +0.6 points),
- access model lesson plans integrating technology (*M* = 3.4, +0.3 points), and
- deliver information using presentation software (*M* = 2.9, +0.3 points).

Students' Use of Technology. On this scale, teachers reported how often students in their typical class used technology in various ways during class time. The effect size for this scale was large because treatment teachers reported more frequent technology use on all items. The largest differentials indicated that teachers in immersed schools more often than control teachers had students use technology to:

- express themselves in writing (*M* = 3.4 on the 5-point scale, +0.9),
- learn and practice skills (*M* = 3.4, +0.8 points),
- conduct Internet research on an assigned topic (*M* = 3.3, +0.8 points),
- conduct multimedia research (reference CDs, online encyclopedias), (*M* = 2.8, +0.8 points),
- create and make presentations (*M* = 2.7, +0.6 points),
- visually represent or investigate concepts (*M* = 2.5, +0.6 points), and

- produce multimedia reports/projects (*M* = 2.4, +0.6 points).

Integration. Measurement of integration encompassed three latent variables: Technology Integration, Learner-Centered Instruction, and Resistance to Integration. Teachers rated items on a 7-point scale from 1 (*not at all true of me now)* to 7 (*very true of me now*).

Technology Integration**.** This scale included items gauging teachers' actions supporting curricular and instructional infusion of technology. Strong differences emerged between comparison groups on all items. Teachers in immersed schools were more likely than control teachers to report:

- I allocate time for students to practice their computer skills (*M* = 4.7, +1.6 points),
- I plan computer-related activities in my classroom that will improve my students' basic skills (*M* = 5.0, +1.4 points),
- My students discover innovative ways to use classroom computers to make a difference in their lives (*M* = 4.7, +1.3 points),
- Using cutting edge technology and computers, I have stretched the instructional computing in my classroom (*M* = 4.2, +1.3 points), and
- My students authentic problem solving is supported by a vast array of computer-based tools and technology (*M* = 3.9, +1.2 points).

Learner-Centered Instruction**.** In spring, teachers in immersed schools expressed stronger affiliations with principles of learner-centered instruction than control teachers. Treatment teachers were more likely to report that students are involved in establishing individual learning goals (*M* = 3.7, +0.3 points), and their instructional approach emphasizes experiential learning, student involvement, and real-world experiences (*M* = 4.3, +0.3). Moreover, in immersed classrooms, teachers indicated more consistent provision of alternative assessment opportunities for students (*M* = 4.3, +0.5 points) and the selection of instructional materials allowed students to use information and inquiry skills (*M* = 4.3, + 0.7 points).

Resistance to Integration. Teachers at immersed campuses also expressed lower levels of resistance to technology integration. They were less likely than control teachers to indicate that using classroom computers is not a priority for me this school year), computers are not a necessary part of my classroom instruction, and the use of computers is not practical for my students.

Overall, although teachers in immersed schools expressed stronger support than control teachers for integration variables, average ratings, which typically ranged between 3 and 5 on the 7-point scale, indicated only moderate commitment to Technology Integration and Learner-Centered Instruction.

Collaboration. The collaboration scale measures teacher interactions with colleagues supporting improvements in instructional practices, including coaching and mentoring from internal and external sources, developing technology lessons collectively, and exchanging information about students and their learning. On each of the scale items, treatment teachers indicated more frequent collaborations than control teachers. Collaborations that distinguished the comparison groups indicated that treatment teachers more often:

- exchanged feedback with other teachers based on student work that used technology (M = 3.1, +0.7 points),
- consulted with other teachers about certain students' technology skills and use (M = 3.1, +0.6 points),
- had informal discussions with colleagues regarding strategies for integrating technology (M = 3.4, +0.5 points),
- received coaching or mentoring from an internal source, such as another teacher or technology coordinator (M = 3.1, +0.4 points), and
- received coaching or mentoring from an external (non-school) source, such as a professional curriculum developer (M = 2.6, +0.4 points).

Associations of Teacher Characteristics and Mediating Variables

Results for HLM analyses also revealed important associations between teacher characteristics and technology-related variables.

Teacher experience (net of fall scores, certification status, and gender) was a significant positive predictor of Innovative Culture, but a significant negative predictor of Technology Proficiency, Student's Use of Technology, and Technology Integration.

Female teachers (net of fall scores, certification status, and experience) had higher spring 2005 scores than *males* on: Classroom Integration, Collegial, Innovative Culture, Parent and Community Support, Technology Proficiency, Professional Productivity, Technology Integration, and Learner-Centered Instruction. Net of the predictors, females had lower Resistance to Integration scores than males.

Technology certified teachers (net of fall scores, gender, and experience) had higher spring 2005 scores than non-certified teachers on: Leadership and System Support, Technical Support, Collaboration, Technology Integration, and Learner-Centered Instruction.

Additionally, ancillary statistics in Tables 5.3 and 5.4 show that fall scores, gender, experience, and certification status reduced teacher-level variance in spring 2005 scores by anywhere from 20.3% (Parent, Community Support) to 69.2% (Technology Proficiency). Moreover, the *immersion* variable, net of the teacher-level predictors, reduced between-school variance in spring 2005 scores by anywhere from 16.8% (Technical Support) to 77.2% (Student's Use of Technology).

Table 5.5. Ancillary Statistics for HLM Analyses of School- and Teacher-Level Variables

School-Level Scale	Intraclass Correlation or Proportion of Outcome Variation Between Schools[a]	Percentage of Variance Explained by the Teacher-Level Model[b]	Percentage of Variance Explained by the School-Level Model[c]
School-Level Variables			
Leadership and System Support	0.130	0.466	0.273
Classroom Integration	0.141	0.341	0.683
Technical Support	0.244	0.260	0.168
Collegial, Innovative Culture	0.084	0.323	0.549
Parent, Community Support	0.121	0.203	0.839
Teacher-Level Variables			
Technology Proficiency	0.028	0.692	0.306
Professional Productivity	0.093	0.496	0.684
Student's Use of Technology	0.172	0.399	0.772
Collaboration	0.117	0.332	0.632
Technology Integration	0.186	0.473	0.728
Learner Centered Instruction	0.039	0.311	0.756
Resistance to Integration	0.061	0.288	0.216

[a] The intraclass correlation measures the degree of dependence in the spring 2005 scale scores among the teachers sharing a school. A value of 0 would indicate no need for a multilevel analysis.
[b] This is a measure of the proportion reduction in within-school variance computed by comparing the within-school variance from a null model (no predictors) with the within-school variance from the teacher-level model (fall 2004 scale score, teacher experience, teacher certification status, and teacher gender) described above.
[c] This is a measure of the proportion reduction in between-school variance computed by comparing the between-school variance from the level 1 or teacher-level model with the between-school variance from the school-level model (immersion indicator variable as the predictor) described above.

Effects of Immersion on Classroom Practice

Researchers conducted classroom observations in fall 2004 and again in spring 2005 in a sample of classrooms for sixth-grade teachers of core subjects (reading/English language arts, mathematics, science, and social studies. Classroom observations were conducted by single observers (about 75% of classrooms) and pairs of observers (about 25% of classrooms). Paired observations permitted the calculation of inter-observer agreement. Altogether, we conducted 128 observations in 22 schools in fall 2005 (11 schools each for treatment and control). In spring 2005, we expanded observations to include 247 observations in all of the 44 schools.

During observations, data collectors recorded descriptive information about the classroom environment; time-interval ratings of classroom organization, teacher activities and technology use, student activities and technology use, student engagement, and student collaboration. Observers also recorded notes during the observations to capture the lesson's content focus and objectives, teachers' questioning strategies (lower and higher order), and students' learning experiences.

Following classroom observations, observers used time-interval ratings and descriptive notes to rate the *Intellectual Challenge* of classroom work (rating scales developed by Newmann, Secada, & Wehgle, 1995). One section of the Observation of Teaching and Learning (OTL) instrument included 5-point rating scales for four dimensions of the intellectual quality of instruction:

- *Construction of Knowledge: Higher Order Thinking*. Instruction involves students in manipulating information about ideas by synthesizing, generalizing, explaining, hypothesizing, or arriving at conclusions that produce new meaning and understanding for them.

- *Disciplined Inquiry: Deep Knowledge.* Instruction addresses central ideas of a topic or discipline with enough thoroughness to explore connections and relationships and to produce relatively complex understandings.

- *Disciplined Inquiry: Substantive Conversation*. Students engage in extended conversational exchanges with the teacher or peers about subject matter in a way that builds an improved and shared understanding of ideas or topics.

- *Value Beyond School: Connections to the World Beyond the Classroom.* (Newmann, Secada, & Wehgle, 1995).

An aggregate score across the four scales was used as an overall measure of the Intellectual Challenge of instruction for each teacher. In addition to training raters to enhance their observer agreement, we also utilized Many-Facets Rasch Analysis (Linacre, 2004) to adjust the measure of Intellectual Challenge for the relative severity (or leniency) of each observer.

Table 5.6 reports the adjusted Intellectual Challenge scores for immersed and control teachers in the fall of 2004 and spring 2005. In fall, the control teachers' mean adjusted score (1.75) was higher than the immersed teachers' score (1.45) (t = 2.35, df = 140, p = 0.02). This difference in scores favoring the control teachers represented a moderate effect size (0.39). Thus, in fall, the sample of control teachers engaged students in lessons involving a higher level of intellectual challenge. That is, lessons required a higher level of thinking, delved into topics more thoroughly, engaged students in more substantive conversation, and made stronger connections with students' background experiences and the world beyond the classroom. However, in spring 2005, the difference between the immersed teachers' mean adjusted score (1.69) and control teachers' score (1.66) was significantly insignificant (t = 0.25, df = 233, p = 0.80). Thus, fall-to-spring comparisons revealed some progress by teachers in immersed schools toward more challenging lessons.

Table 5.6. Adjusted Intellectual Challenge Scores for Sixth-Grade Teachers' Lessons in Immersed and Control Schools

	Immersion			Control					Effect
Group	n	Mean	*SD*	*N*	Mean	*SD*	*t*-value	*p*	Size
Fall 2004	69	1.45	0.85	73	1.75	0.68	2.35	0.02*	0.39
Spring 2005	117	1.69	0.85	118	1.66	0.86	0.25	0.80	--

Note. Intellectual Challenge scores could range from 1 (lowest rating) to 5 (highest rating). *Difference is statistically significant.

Table 5.7 provides a comparison of the adjusted Intellectual Challenge scores for immersed and control teachers who were observed in both the fall of 2004 and again in the spring of 2005. Neither group's change in adjusted scores was statistically significant (t = 1.09, df = 57, p = 0.28 for immersed and t = -1.18, df = 58, p = 0.24 for control). However, teachers in immersed schools showed an increase in the Intellectual Challenge of instruction, while the challenge of control teachers' lessons decreased. Additionally, in a model predicting the spring adjusted Intellectual Challenge score from the fall adjusted score and a treatment variable (1 = immersion, 0 = control), the treatment effect favoring the immersed teachers was positive but not significant (unstandardized coefficient = 0.154, standardized coefficient = 0.038, $t = 0.411$, probability = 0.682).

Table 5.7. Adjusted Intellectual Challenge Scores for Sixth-Grade Teachers in Immersed and Control Schools with Pre- and Post-Measures

		Fall 2004		Spring 2005			
Group	*N*	Mean	*SD*	Mean	*SD*	*t*-value	*p*
Immersion	58	1.50	0.71	1.64	0.83	1.09	0.28
Control	59	1.81	0.92	1.65	0.84	-1.18	0.24

Note. Intellectual challenge scores could range from 1 (lowest rating) to 5 (highest rating). The difference between the Intellectual Challenge scores for immersion and control teachers in spring 2005, net of fall 2004 scores, was statistically insignificant.

6. Effects of Technology Immersion on Students and Learning

In the theoretical framework for technology immersion, we hypothesized that an improved school environment for technology would lead to teachers who have greater technology proficiency and use technology more often for their own professional productivity. Moreover, in immersed schools, teachers have students use technology frequently in their classrooms, and technology provides a means to enhance the intellectual challenge and relevance of lessons. Findings reported in the previous section suggest that teachers in immersed middle schools, indeed, have advanced in many of these areas in comparison to their counterparts in control schools. Based on expected changes in teacher knowledge and practices in immersed schools, we also postulated that improved school and classroom environments for technology would lead students to greater technology proficiency and use, more frequent peer collaboration, enhanced personal self-direction, more challenging and relevant school work, and stronger engagement in school and learning. In this section, we present findings on the effects of technology immersion on students and their learning experiences.

Student Mediating Variables—HLM Analysis

Data on student mediating variables come from paper-and-pencil surveys of sixth-grade students conducted in the fall of 2004 and again in the spring of 2005. The *Student Questionnaire* measured students' technology proficiency, technology use, and technical problems. The survey also gauged students' opportunities to work with peers in small groups and their satisfaction with school. For Technology Proficiency, students rated their skills in using technology applications on a 5-point scale ranging from 1 (*I can do this not at all or barely*) to 5 (*I can do this extremely well*). Students indicated their skill level on 22 statements aligned with the Texas Technology Applications standards.

Students also were asked to report the frequency with which their teachers had them use specific technology activities (e.g., use a word processor, use a spreadsheet, create a presentation) in *all* of their English language arts, mathematics, social studies, and science classes combined. Students reported the frequency of technology use in 12 areas on a 5-point scale: 1 (*never*), 2 (*rarely: a few times a year)*, 3 (*sometimes: once or twice a month*), 4 (*often: once or twice a week*), and 5 (*almost daily*). Similarly, students indicated about how often various Technology Problems (7 items) happen when they try to use a computer at school and the frequency of their engagement in Small-Group Work (6 items). Students also rated their level of Satisfaction with School by indicating the extent of their agreement with 6 statements on a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Measures of internal consistency for the student scales ranged from 0.76 to 0.94.

In fall 2004, a total of 4,824 sixth-grade students (87%) participated in the survey. Respondents included 2,319 treatment students (90%) and 2,505 control students (84%). In spring 2005, 4,538 students responded to the survey (82%), with 2,053 treatment (80%) and 2,485 control students (83%).

Sixth graders also completed the Style of Learning Inventory (SLI) in fall and spring. The SLI (developed by he Metiri Group, 2004), measures Self-Directed Learning. Students rated 48 statements addressing their self-regulated learning on a 7-point scale ranging from 1 (*completely false)* to 7 (*completely true).* The internal consistency for the *SLI* total score is 0.88. In fall 2004, a total of 4,584 students (82%) completed the *SLI* as a baseline measure. Respondents included 2,142 treatment students (83%) and 2,442 control students (82%). A total of 4,294 students (77%) completed the SLI again in spring 2005, including 2,174 treatment students (85%) and 2,120 control students (71%).

Student response rates were generally acceptable but rates tended to decline from fall to spring. Thus, students without pre- and post-measures were excluded from analyses. In particular, control students' lower response rate compared to treatment students for the SLI in spring 2005 is troublesome (71% versus 85%).

The analyses that follow contrast sixth-grade students in immersion and control schools before and after one school year of the implementation of the Technology Immersion Pilot. Immersion effects are estimated for the following scales: Technology Proficiency, Technology Use in School, Technology Problems, Small-Group Work, Satisfaction with School, and Self-Directed Learning. The effects of immersion on students' self-reported proficiencies and perceptions were analyzed using a two-level hierarchical linear model (HLM).[1]

Student-Level Model

In the student-level model, spring 2005 scale scores from surveys were regressed on fall 2004 scale scores, economic status (0 if not disadvantaged, 1 if disadvantaged), African American status (0 if not African American, 1 if African American), Hispanic status (0 if not Hispanic, 1 if Hispanic) and gender (0 if male, 1 if female). That is,

$$Y_{ij} = \beta_{0j} + \beta_{1j}(\text{Fall 2004 scale score}) + \beta_{2j}(\text{Disadvantaged}) + \beta 3_j(\text{African American}) + \beta 4_j(\text{Hispanic}) + \beta 5_j(\text{Female}) + r_{ij.}$$

When Technology Proficiency was the dependent variable, having a home computer in the fall of 2004 (0 if family does not have a home computer, 1 if family has a home computer), and not economic status, was used as a student-level predictor.

With all of the 2005 student survey scales, significant variation was found across schools (although in cases like student Satisfaction with School the variation was not large). Variation across schools justifies the use of HLM (see the intraclass correlations in Table 6.5). Thus, the school means (β_{0j}) were specified as randomly varying. The coefficients for fall 2004 scale score (β_{1j}) were specified as fixed unless the reduction in the deviance statistic (significant chi square) justified a random specification. The coefficients for economic status, Hispanic, African American, and gender were specified as fixed.

School-Level Model

A school-level model was developed to answer the question of whether immersed schools had higher scale scores than control schools, after controlling for initial scale scores, ethnicity, gender, and economic status. That is,

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(Immersion\ dummy) + \mu_{0j}.$$

The immersion dummy was an indicator variable with a value of 1 for an immersed school and a value of 0 for a control school.

Table 6.1 provides descriptive statistics for the student- and campus-level models on the variables measured through the student survey (e.g., Technology Proficiency). Table 6.2 provides statistics for Self-Directed Learning, as measured by the SLI.

Table 6.1. Descriptive Statistics for Student Mediating Variables (Survey)

Variable Name	N	Mean	SD	Minimum	Maximum
Student-Level Descriptive Statistics					
Technology Proficiency (2004)	4,684	2.83	0.91	1.00	5.00
Technology Proficiency (2005)	4,015	3.17	0.86	1.00	5.00
Technology Use in School (2004)	4,367	2.05	0.80	1.00	5.00
Technology Use in School (2005)	3,715	2.44	0.84	1.00	5.00
Technology Problems (2004)	1,707	2.21	0.96	1.00	5.00
Technology Problems (2005)	1,233	2.44	0.96	1.00	5.00
Small-Group Work (2004)	4,400	2.78	0.91	1.00	5.00
Small-Group Work (2005)	3,795	2.85	0.88	1.00	5.00
Satisfaction with School (2004)	4,499	3.73	0.75	1.00	5.00
Satisfaction with School (2005)	3,830	3.72	0.77	1.00	5.00
Disadvantaged (1 = yes, 0 = no)	4,782	0.75	0.43	0.00	1.00
Home Computer (1 = yes, 0 = no)	4,796	0.68	0.47	0.00	1.00
Hispanic (1 = yes, 0 = no)	4,824	0.67	0.47	0.00	1.00
African American (1 = yes, 0 = no)	4,824	0.10	0.30	0.00	1.00
Female (1 = yes, 0 = no)	4,824	0.49	0.50	0.00	1.00
Campus-Level Descriptive Statistics					
Immersion status (1 = yes, 0 = no)	44	0.50	0.51	0.00	1.00

Table 6.2. Descriptive Statistics for Self-Directed Learning (SLI)

Variable Name	N	Mean	SD	Minimum	Maximum
Student-Level Descriptive Statistics					
Self-Directed Learning (2004)[a]	3,485	4.58	0.77	1.80	7.00
Self-Directed Learning (2005)[a]	4,294	4.43	0.77	1.45	7.00
Disadvantaged (1 = yes, 0 = no)	4,294	0.72	0.45	0.00	1.00
Hispanic (1 = yes, 0 = no)	4,290	0.64	0.48	0.00	1.00
African American (1 = yes, 0 = no)	4,290	0.11	0.31	0.00	1.00
Female (1 = yes, 0 = no)	4,294	0.49	0.50	0.00	1.00
Campus-Level Descriptive Statistics					
Immersion status (1 = yes, 0 = no)	41	0.64	0.50	0.00	1.00

[a] Style of Learning Inventory (SLI) items measured on a 7-point scale.

Effects of Immersion on Mediating Variables

Findings from analyses are summarized in Table 6.3. Additional statistical details for the HLM models are reported in Tables 6.4 and 6.5. Summary results show that technology immersion had a statistically significant effect on students in a number of key areas and the magnitude of the effect was usually moderate to large. After controlling for fall 2004 scale scores, economic status, ethnicity, and gender, sixth-grade students in immersed schools had significantly higher scale scores than students in control schools on:

- Technology Proficiency (0.40 points, 0.47 standard deviation units),
- Technology Use in School (0.80 points, 0.96 standard deviation units),
- Small-Group Work (0.32 points, 0.36 standard deviation units), and
- Satisfaction with School (0.10 points, 0.13 standard deviation units).

Moreover, although students in immersed schools had access to and used technology more frequently, after controlling for key variables, there was no significant difference in Technical Problems reported by students in immersed and control schools.

Table 6.3. Immersion Effect Analyses of Student Mediating Variables

Scale	Immersion Effect Net of Fall Score, Ethnicity, Gender, & Economic Status	Magnitude of Effect in Standard Deviation Units[a]
Technology Proficiency	Yes	0.47 (moderate)
Technology Use in School	Yes	0.96 (large)
Technical Problems	No	--
Small-Group Work	Yes	0.36 (moderate)
Satisfaction with School	Yes	0.13 (small)
Self-Directed Learning	No	--

Note. The interpretation is that an effect size greater than 0.5 is large, 0.5-0.3 is moderate, 0.3-0.1 is small, and anything smaller than 0.1 is trivial.

We also hypothesized that the independent and individualized learning opportunities allowed through one-to-one technology access would have a positive effect on students' self-directed learning. However, after controlling for fall 2004 scale scores, economic status, ethnicity, and gender, there was no significant difference in the spring 2005 scale scores of students in immersed and control schools on Self-Directed Learning. It is possible, however, that changes in students' self-directed learning behaviors may require a longer period of time to emerge. Measurement error also may be a factor, especially considering the lower response rate for students in spring.

Student responses to the individual scale items help to explain the positive effects of immersion on mediating variables.

Technology Proficiency. In spring 2005, sixth graders attending immersed schools reported higher technology skill levels than control students on each of the items measuring the Texas Technology Application standards. For the most part, treatment students believed they could use technology applications either *fairly well* or *very well*. Skill areas with the greatest mean differences favoring treatment students included the ability to:

- send an attachment to an email (*M* = 3.4, +0.8 points);
- use software to create a presentation (*M* = 4.0, +0.7 points);
- open, create, modify, print, and save documents (*M* = 4.1, +0.6 points);
- use a spreadsheet to create graphs (*M* = 3.4, +0.6 points); and
- keep track of Web sites I have visited (*M* = 3.4, +0.4 points).

Technology Use in School. Students in immersed schools also began to use technology in new ways. The greatest differences in technology use reported by students in spring showed that core-subject area teachers in immersed schools more often had students:

- conduct Internet research on an assigned topic (*M* = 3.6, +1.0 points),
- use a word processor to write a story or report (*M* = 3.4, +1.0 points),
- create a presentation and present information (*M* = 3.2, +0.9 points),
- communicate by email about topics you are studying (*M* = 2.7, +0.8 points),
- create a database of information for a class project (*M* = 2.8, +0.7 points), and
- use technology to complete a test or quiz (*M* = 2.7, +0.6 points).

Even though technology use increased, frequency ratings showed that students in immersed schools typically participated in these technology activities only *sometimes,* e.g., *once or twice a month*.

Technical problems. Problems with technology appear to be only an occasional nuisance for sixth-grade students (e.g., *once or twice a month*). Still, individual item scores indicated that control students more often had problems with broken or slow computers and having to share a computer to complete assignments. In contrast, students in immersed schools more frequently noted problems with websites blocked by a filter.

Small-Group Work. Students in immersed schools reported more frequent opportunities to work with their classmates in small-group activities than control students on all of the items (e.g., tutor or coach each other, brainstorm solutions to problems, and discuss assignments). The differences between groups were greatest in two areas. Treatment students more often worked with classmates in small groups to "produce a report or project" (M = 3.3, +0.6 points) or to "make a presentation for the rest of the class" (M = 3.0, +0.5 points). These activities typically occurred *once or twice a month*.

Satisfaction with school. In spring, students in immersed schools expressed slightly higher levels of satisfaction in all of the six areas measured. The largest disparity between the comparison groups centered on two aspects of student self-motivated learning: "I am satisfied with the work that I do in my classes," and "What I learn is more important than the grade I receive."

Overall results for HLM analyses reported in Table 6.4 also revealed important associations between the characteristics of sixth graders (i.e., gender, economic status, and minority status) and technology-related variables. Results indicate that:

- *Female students* (net of fall scores, economic status, and ethnicity) had significantly higher spring 2005 scores than *males* on: Technology Proficiency, Small-Group Work, Self-Directed Learning, and Satisfaction with School.
- *A computer at home* in fall 2004 (net of fall scores, gender, and ethnicity) was a significant predictor of a student's Technology Proficiency.
- *Hispanic* s*tudents* (net of fall scores, gender, and economic status), had significantly lower spring 2005 scores than non-Hispanic students on Technology Proficiency.
- *African American students* (net of fall scores, gender, and economic status) had significantly higher spring 2005 scores than non-African American students on Technology Use in School and Small-Group Work.

These findings suggest that greater attention may need to be directed toward the learning needs of male students in middle schools, both immersed and control. Moreover, results reinforce the important role of immersion in closing the "equitable access to technology" gap between students who have and do not have computers in the home. Our data suggest that about a third of sixth-grade students did not have a computer in their home in fall 2004. For the ethnic groups, it is unclear whether self-reported information reflects actual differences in proficiencies and events or simply differences in students' perceptions. Additional analyses may shed light on differential effects associated with ethnicity.

Table 6.4. Immersion (Fixed) Effect Analyses of Student Mediating Variables

School-Level Scale	School-Level Analysis	Gamma Coefficient	Standard Error	*t*
Technology Proficiency	Base	2.943	0.051	57.08***
	Immersed campus	0.404	0.053	7.58***
	Fall score	0.500	0.021	23.90***
	Home computer	0.106	0.025	4.15***
	Disadvantaged	-0.025	0.029	-0.86
	Hispanic	-0.074	0.035	-2.14*
	African American	0.026	0.055	0.46
	Female	0.068	0.029	2.33*
Technology Use in School	Base	2.002	0.051	39.21***
	Immersed campus	0.804	0.071	11.26***
	Fall score	0.294	0.021	13.73***
	Disadvantaged	0.079	0.028	2.86**
	Hispanic	0.044	0.044	0.99
	African American	0.214	0.045	4.76***
	Female	0.002	0.025	0.07
Technical Problems	Base	2.614	0.121	21.63***
	Immersed campus	-0.081	0.096	-0.85
	Fall score (pooled)	0.270	0.046	5.93***
	Disadvantaged	-0.122	0.141	-0.87
	Hispanic	-0.059	0.123	-0.48
	African American	-0.050	0.108	-0.46
	Female	0.104	0.073	1.42
Small-Group Work	Base	2.575	0.048	53.74***
	Immersed campus	0.318	0.055	5.74***
	Fall score	0.251	0.018	13.59***
	Disadvantaged	0.077	0.038	2.06*
	Hispanic	0.021	0.039	0.53
	African American	0.256	0.047	5.42***
	Female	0.103	0.032	3.21**
Satisfaction with School	Base	3.577	0.041	86.81***
	Immersed campus	0.101	0.033	3.09**
	Fall score	0.393	0.028	13.79***
	Disadvantaged	0.054	0.029	1.90
	Hispanic	0.023	0.031	0.76
	African American	0.062	0.043	1.44
	Female	0.084	0.032	2.63**
Self-Directed Learning	Base	4.410	0.041	107.42***
	Immersed campus	0.046	0.039	1.19
	Fall score	0.617	0.025	24.77***
	Disadvantaged	-0.004	0.030	-0.13
	Hispanic	-0.065	0.034	-1.93
	African American	0.058	0.047	1.24
	Female	0.070	0.021	3.39**

$^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$.

Ancillary statistics in Table 6.5 show that fall scores, economic status, ethnicity, and gender reduced student-level variance in spring 2005 scores by anywhere from 6.2% (Technical Problems) to 35.1% (Self-Directed Learning). The immersion variable, net of the student-level predictors (school-level model), reduced between-school variance in spring 2005 scores by anywhere from 0.0% (Technical Problems) to 75.9% (Technology Use in School).

Table 6.5. Ancillary Statistics Related to the HLM Analyses of Student Variables

Scale	Intraclass Correlation or Proportion of Outcome Variation Between Schools[a]	Percentage of Variance Explained by the Student-Level Model[b]	Percentage of Variance Explained by the School-Level Model[c]
Technology Proficiency	0.092	0.341	0.604
Technology Use in School	0.259	0.094	0.759
Technical Problems	0.045	0.062	0.000
Small-Group Work	0.083	0.093	0.568
Satisfaction with School	0.030	0.158	0.362
Self-Directed Learning	0.044	0.351	0.072

[a] The intraclass correlation measures the degree of dependence in the spring 2005 scale scores among the students sharing a school. A value of 0 would indicate no need for a multilevel analysis.
[b] This is a measure of the proportion reduction in within-school variance computed by comparing the within-school variance from a null model (no predictors) with the within-school variance from the student-level model (fall 2004 scale score, ethnicity, economic status, and gender) described above.
[c] This is a measure of the proportion reduction in between-school variance computed by comparing the between-school variance from the level 1 or student-level model with the between-school variance from the school-level model (immersion indicator variable as the predictor) described above.

Student Mediating Variables—Additional Indicators

Technology Use in Core-Subject Classes

In addition to asking students to describe their overall use of technology in core subjects, we also gathered information specific to each content area (reading English/language arts, math, science, social studies). Measuring technology use in core subjects was important because of its link to the measurement of student achievement in core subjects. To gauge the frequency of technology use, students indicated how often they used technology in each of their core classes (one item for each subject) on a 5-point scale: (*never*, *rarely: a few times a year, sometimes: once or twice a month, often: once or twice a week,* and *almost daily*). We used paired samples *t*-tests, as opposed to non-parametric tests which are recommended for analyzing ordinal data with a non-normal distribution, because the *t*-test is "robust against violations of the normality assumption" (Rasch & Guiard, 2004).[2]

Results in Table 6.6 show that students in immersed schools reported significant increases in their technology use in all of their core-subject classes. (Note that similar conclusions would have been reached by using a non-parametric test.)[3] Effect sizes for these increases were somewhat larger, in the moderate range, for science (0.38) and social studies classes (0.40) compared to other subject areas. Although students in immersed schools used technology most often in reading/English language arts classes (M = 2.95, *nearly once or twice a week*), the effect was small because students had used technology more often in these classes in the fall. On average, students used technology about once or twice a week in science (M = 2.87) and slightly less often in social studies (*M* = 2.64). Students reported using technology least often in math classes (*M* = 2.39).

Table 6.6. Sixth Graders' Technology Use Frequency in Core-Subject Classes

Class	Fall 2004 Mean	Spring 2005 Mean	*t-value*	*p*	Effect Size
Immersion					
Reading/ELA	1.92	2.95	-26.71	0.000	0.279
Math	1.25	2.39	-28.03	0.000	0.299
Science	1.43	2.87	-33.94	0.000	0.384
Social Studies	1.23	2.64	-34.91	0.000	0.397
Control					
Reading/ELA	1.89	1.90	-0.40	0.688	0.000
Math	1.25	1.35	-2.69	0.007	0.003
Science	1.26	1.32	-1.60	0.110	0.001
Social Studies	1.35	1.38	-0.87	0.385	0.000

Notes. Students responded to a single item for each subject on a 5-point scale: 0 (*never*), 1 (*rarely: a few times a year*), 2 (*sometimes: once or twice a month*), 3 (*often*: *once or twice a week)*, and 4 (*almost daily*). Effect size or eta square was calculated as $t^2/(t^2 + N - 1)$. Numbers ranged from 1,844 to 1,850 for immersed students and from 2,086 to 2,104 for control students.

For control students, there was a significant reported increase in technology use only in math. However, the effect size for this increase was almost negligible (0.003). In spring, control students reported that they used technology, on average, slightly more than *a few times a year* in math, science, and social studies and about *once or twice a month* in reading/English language arts.

Student Engagement

The measurement of student engagement stems from our review of the literature, with engagement in school and learning assessed in three ways. First, we hypothesized that students in schools immersed in technology would express higher levels of satisfaction with their schools and the kinds learning opportunities provided. Secondly, we anticipated that increased technology access and use would lead to improved student conduct and fewer discipline problems. Third, we posited that there would be a positive association between immersion and improved school attendance. Findings on student engagement presented below suggest that students in immersed schools exhibited stronger school engagement on at least some indicators.

Satisfaction with School. Students' satisfaction with school provided one measure of engagement, and as reported earlier in the HLM analyses, students in immersed schools expressed significantly higher satisfaction with school than students in control schools, although the effect size was small (0.13).

Student discipline and behavior. As an additional measure of engagement, we collected student-level data from schools in spring 2005 on disciplinary actions that occurred during the 2004-05 school year. Disciplinary indicators included three variables:

- The number of student office referrals (i.e., number of times a student was referred to the office for disciplinary purposes),
- Student suspension from school (i.e., either an in-school suspension or an out-of-school suspension), and
- Student placement in an alternative education setting [e.g., Alternative Education Program (AEP), Disciplinary Alternative Education Program (DAEP), or Juvenile Justice Alternative Education Program (JJAEP)].

Findings from analyses for sixth-grade students reported below suggest that students in immersed schools had fewer behavioral and disciplinary problems than their counterparts in control schools.

Sent to the office during the school year. To determine whether sixth graders in immersed schools were sent to the office less frequently than students in control schools we conducted *t*-tests of differences between the mean numbers of office referrals.[4] Results of the *t*-test were significant, $t = 6.07$, $p < 0.001$. Specifically, there were 2,885 sixth graders in immersed schools who were sent to the office an average of 0.85 times, and 3,214 sixth-grade students in the control schools who were sent to the office an average of 1.40 times (see Figure 6.1). The effect size for the mean difference (0.55) was small (0.16).

Number of Times Sent to the Office During the School Year

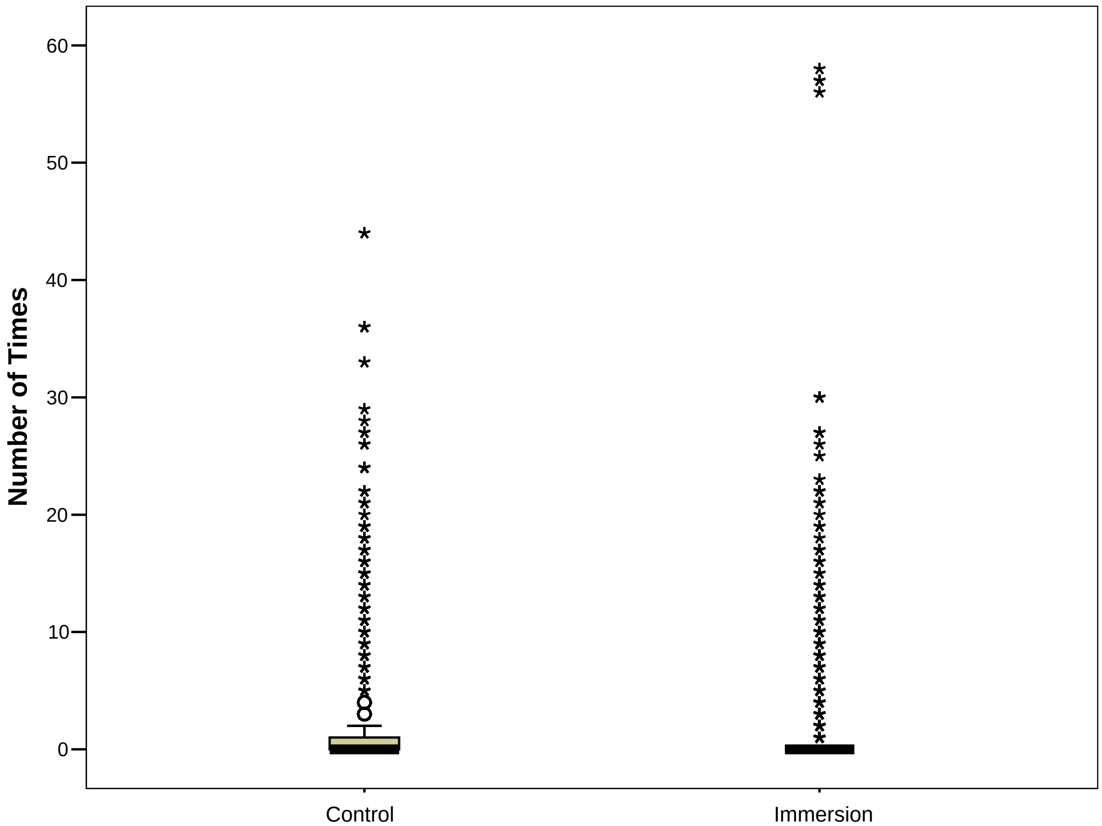

Figure 6.1. Office-referral distributions for grade 6 students in immersion and control schools.

We also conducted a two-way contingency table analysis to determine whether immersed (treatment) schools had a lower proportion of sixth-grade students who were sent to the office at least once during the school year. The two variables were “sent to the office at least once during the school year” (yes or no) and group status (treatment or control). Group status and whether or not a sixth-grade student was sent to the office at least once were found to be significantly related, chi-square (df = 1, N = 6,099, chi-square = 86.57, $p < 0.001$, phi = 0.12). Sixth-grade students in immersed school were sent to the office at a lower rate than students in control schools, although the effect was small (phi of 0.12). The proportions of sixth-grade students who were sent to the office at least once during the school year were 0.193 (19.3% or 577 out of 2,885) for the treatment schools and 0.310 (31.0% or 997 out of 3,214) for the control schools and (see Figure 6.2).

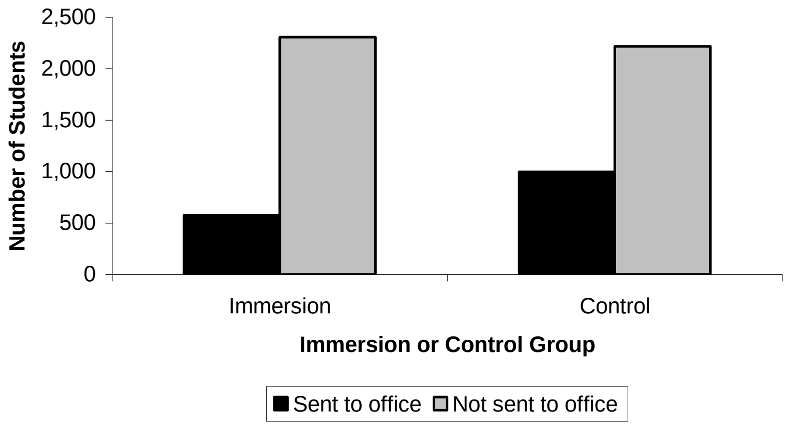

Figure 6.2. Number of grade 6 students sent to the office at least once by comparison group.

Suspended during the school year. We conducted an additional two-way contingency table analysis to determine whether sixth-grade students in immersed schools (treatment) had a lower school suspension rate than students in control schools. The two variables were "suspended at any time during the year" (yes or no) and group status (treatment or control). Results showed there was a significant relationship between the school attended and whether or not a sixth-grade student was suspended [chi-square (df = 1, N = 6,099, chi-square = 24.98, $p < 0.001$, phi = 0.06)]. Sixth graders in immersed schools had a lower school suspension rate than did students in control schools, although the effect was small (phi of 0.06). The proportions of sixth graders who were suspended during the school year were 0.0052 (0.52% or 15 out of 2,885) for the treatment schools and 0.0196 (1.96% or 63 out of 3,214) for the control schools (see Figure 6.3).

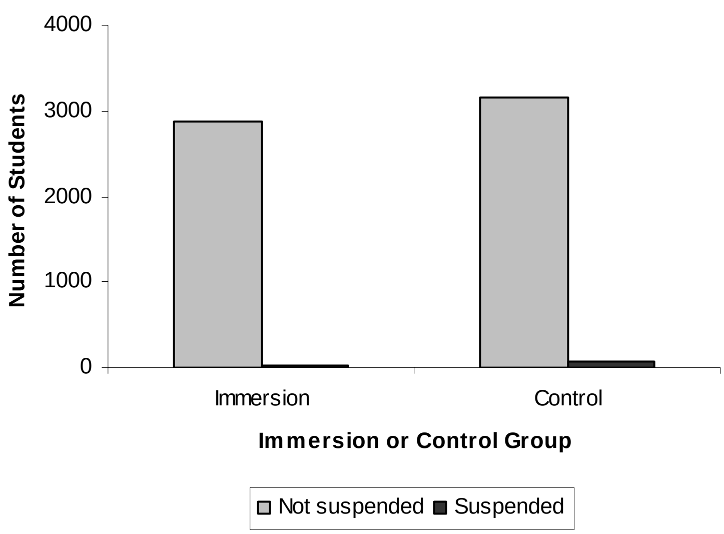

Figure 6.3. Number of grade 6 students suspended at any time during the school year by comparison group.

Placed in an Alternative Education Program. Another two-way contingency table analysis was conducted to determine whether sixth-grade students in immersed schools were less likely to be placed in an Alternative Education Program (AEP) than control students. The two variables were "placement in an AEP" (yes or no) and group status (treatment or control). Results revealed there was no significant difference between immersed and control schools in the likelihood of a student being placed in an AEP [chi-square (df = 1, N = 6,099, chi-square = 2.88, $p = 0.090$)]. In fact, the proportion of sixth graders placed in an AEP during the school year was slightly lower for control schools [0.0118 (1.18%) or 38 out of 3,214] than for the treatment schools [0.0170 (1.70%) or 49 out of 2,885].

In general, very few sixth graders are suspended from school or placed in AEPs. It will be interesting to examine statistics on the more severe disciplinary actions for this cohort of sixth graders as they advance into seventh and eighth grade.

Student attendance. Another indicator of school engagement is the attendance rate of students. In Table 6.8 and Figure 6.4, we compare the end-of-year attendance rates of sixth-grade students in treatment and control schools from one and two years prior to project implementation and after one year of project implementation. Results show that the average attendance rates of students in immersion schools were approximately 0.4 to 0.5 percentage points lower than the attendance rates of control students. This pattern was consistent before project implementation and continued one year after project implementation. Thus, there was no apparent "boost" in attendance for students who participated in the project. Statistically, the differences between the attendance rates for treatment and control students were significant, although effect sizes were small.

Table 6.8. Group Differences for Sixth-Grade Student Attendance Rates

	Immersion		Control		*Differ-ence*			*Effect*
Year	Mean	SD	Mean	SD		*t-value*	*p*	*Size*
2002-03	96.64	3.73	97.01	3.35	-0.37	3.80	0.000*	0.10
2003-04	96.65	4.91	97.19	3.43	-0.54	4.57	0.000*	0.13
2004-05	96.10	4.38	96.45	4.28	-0.35	2.89	0.004*	0.08

Source: Individual student data from TEA.
Notes. There were 2,843 grade 6 control students and 2,434 grade 6 immersion students having attendance data from 2003 through 2005. *Statistically significant difference. The effect size is interpreted as follows. A value greater than 0.5 is large, 0.5-0.3 is moderate, 0.3-0.1 is small, and anything smaller than 0.1 is trivial.

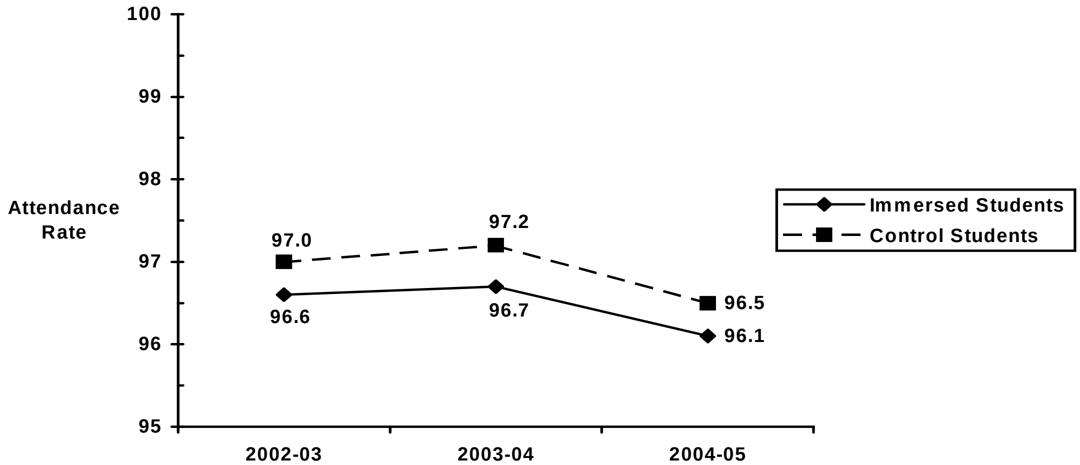

Figure 6.4. Attendance rates of sixth-grade students in immersed and control schools from 2002-03 through 2004-05.

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[1] HLM was used for data analysis because students are clustered within middle schools. As a result, because of selection processes (e.g., schools may attract similar types of students) and shared common backgrounds, students within are more similar to each other than are students from different schools. Consequently, measures within schools may not be independent, and may be more highly correlated than measures of students from different schools. (Note that when a clustering effect is absent, there is no need to utilize HLM.) Ignoring this clustering results in aggregation bias and mostly underestimated standard errors. However, hierarchical linear modeling makes no assumption about independence, and it estimates the degree of clustering of measures and uses this estimate in the calculation of the precision with which immersion effects are estimated (Raudenbush & Bryk, 2002).

[2] Items were ordinal measures with non-normal response distributions (significant Kolmogorov-Smirnov test). However, because the *t* test is "robust against violations of the normality assumption" (Rasch & Guiard, 2004), we used paired samples *t* tests as opposed to non-parametric tests (i.e., Wilcoxon signed ranks test) to analyze these data.

[3] Results for Wilcoxon signed ranks tests for immersed students were significant for each core-content area: reading/ELA $z = -22.77$, $p = 0.000$; math $z = -23.20$, $p = 0.000$; science $z = -26.61$, $p = 0.000$; and social studies $z = -27.05$, $p = 0.000$. Results for Wilcoxon signed ranks tests for control students were significant for math, $z = -2.50$, $p = 0.012$; but not for reading/ELA $z = -0.30$, $p = 0.764$; science $z = -1.62$, $p = 0.106$; and social studies $z = -0.80$, $p = 0.426$.

[4] Analyses revealed that the distribution for the number times sixth-grade students were sent to the office throughout the 2004-05 school year was non-normal and negatively skewed. However, because of the robustness of the *t-test* to violations of the normality assumption we used the parametric statistic (see Rasch & Guiard, 2004). Note that similar conclusions were reached with the non-parametric Mann-Whitney U test ($z = -9.60$, $p < 0.001$), with the mean rank for the immersed students, 2,875.16 being significantly less than the mean rank for control students, 3,206.94.

7. Effects of Technology Immersion on Student Achievement

The ultimate goal of technology immersion is increasing middle school students' achievement in core academic subjects (English language arts, mathematics, science, and social studies) as measured by the Texas Assessment of Knowledge and Skills (TAKS). In our theoretical framework we identified a sequence of causal relationships leading to improved student performance. In the model, we theorize that students who are enrolled in fully immersed schools will experience school and classroom environments that lead them to greater personal proficiencies, more intellectually challenging work, and stronger engagement in their school and learning. In turn, changes in students and their learning experiences will contribute to increased performance on state assessments. In the first year of the technology immersion project, as detailed in previous sections of this report, we have cited noteworthy progress in some areas (e.g., changes in teacher knowledge and practice and improvements in student technology proficiency and school engagement). At the same time, we have pointed to limitations in project implementation during the initial year that almost certainly have influenced the study's finding on student achievement in the initial year (e.g., the small number of days that students actually had their laptops).

Moreover, it is important to note that this is a longitudinal study, and while it was expected that some impacts might emerge in the first year, it was also considered likely that changes in student academic performance would require more than one year to surface. It is also important to understand that the findings on student achievement reported here are represent only a first step in analyzing achievement data. Additional analyses will further explore achievement differences at the classroom level and examine the relationships among school, teacher, and student mediating variables and academic achievement. We also intend to delve more deeply into the relationships between the fidelity of technology immersion implementation and student outcomes. That said, the following sections present TAKS results for sixth-grade students who were enrolled continuously in the 22 immersion and 22 control schools from October 2004 through TAKS testing in April 2005.

Texas Assessment of Knowledge and Skills

Passing Standards and Scale Scores

The TAKS is Texas' criterion-referenced assessment that measures students' mastery of the state's content standards, the Texas Essential Knowledge and Skills (TEKS). At sixth grade, the TAKS assesses reading and mathematics. The TAKS provides several types of scores that will be utilized in this study.

- **Met the standard.** This score represents satisfactory academic achievement. Students who meet this standard performed at a level that was at or somewhat above the state passing standard. Thus, students demonstrated a sufficient understanding of the knowledge and skills measured at the grade level.
- **Commended performance.** This score represents high academic achievement. Students who meet this standard performed at a level that was considerably above the state passing standard. Therefore, students demonstrated a thorough understanding of the knowledge and skills measured at this grade level.
- **TAKS scale score**. The scale score is a statistic that provides a comparison of scores with a standard set at 2100 for each grade level. The scale score can be used to determine whether a student met the minimum standard or achieved commended performance, but it cannot be used to evaluate a student's progress across grades or subject areas. A scale score is provided for all TAKS tests (Texas Education Agency, 2005).

Texas has adopted a phase-in plan for implementing increasingly rigorous passing standards on the TAKS. In 2002-03, passing was initially set at two standard errors of measurement (SEM) below the State Board of Education panel recommended passing standard. In 2004-05, passing standards were fully implemented. Thus, for this study, TAKS scores for 2002-03 and 2003-04 have been converted to reflect the 2004-05 panel recommended passing standard.

z Scores

In addition to the scores provided by the TEA, researchers have also generated a standard score that can be used to compare student progress on TAKS across grade levels. This standardized score—or *z* score—is calculated for each student and for every testing occasion and subject. The *z* score is calculated by subtracting the statewide mean grade-level scale score from each student's scale score and dividing by the statewide scale score standard deviation. The *z* score, which has a mean of zero and a standard deviation of 1.0,
provides a measure of TAKS score growth across grade levels and testing years. A student who scores at the state average will have a score of zero. A student who scores above the state average will have a positive score above zero, whereas a student who scores below the state average will have a negative score.

Progress Toward Meeting TAKS Standards

Information in Table 7.1 compares the performance of sixth-grade students in treatment and control schools across two testing years. Results, which are for students with scores for both 2004 and 2005, show that students at control schools had higher TAKS passing rates for the reading assessment and made slightly greater gains in reading than students in treatment schools. About 81% of control students met the sixth-grade passing standard for reading compared to 72% of students at immersed campuses. Sixth graders' passing rates on the mathematics assessment for both comparison groups declined in 2005; however, they decreased more sharply for students at immersed schools. Moreover, students' scores on the TAKS mathematics assessment are notably lower than for reading. In 2005, only 57% of treatment students and 66% of control students met state passing standards in mathematics.

Table 7.1. TAKS Passing and Commended Performance Rates for Sixth-Grade Students

TAKS Test	Group	N	2004 Percent	2005 Percent	2005-2004 Difference
Met Standard					
Reading	Immersion	1,969	65.5	72.2	6.7
	Control	2,316	71.6	80.7	9.1
Mathematics	Immersion	1,990	67.9	56.9	-11.0
	Control	2,339	71.2	66.2	-5.0
Commended Performance					
Reading	Immersion	1,969	17.9	25.5	7.6
	Control	2,316	22.6	34.2	11.6
Mathematics	Immersion	1,990	21.6	16.4	-5.2
	Control	2,339	23.5	20.7	-2.8

Source: Analysis of individual student data from TEA.
Note. The 2004 passing rates are based on 2005 standards. Students had TAKS scores in both 2004 and 2005. Students were in the same schools for TAKS testing in the spring of 2005 and for TEA's enrollment snapshot in October 2004.

Only a small percentage of students met the higher "commended performance" standard. Students achieved commended status in reading at a higher rate than for mathematics. Comparisons between student groups also showed that greater proportions of control students than treatment students achieved the higher commended standards in both reading and mathematics.

Table 7.2 provides sixth graders' scale scores for TAKS reading and mathematics. As expected, scale-score trends are comparable to passing rates. Students in control schools had higher scale scores for both reading and mathematics assessments, made greater gains in reading across years, and had smaller decreases in mathematics scores. For both student groups, scale scores for reading increased, whereas scores for mathematics declined in 2005.

Table 7.2. TAKS Mean Scale Scores for Sixth-Grade Students

TAKS Test	Group	N	2004 Scale Score	2005 Scale Score	2005-2004 Difference
Reading	Immersion	1,969	2,164.9	2,215.1	50.2
	Control	2,316	2,199.6	2,263.1	63.5
Mathematics	Immersion	1,990	2,195.2	2,145.7	-49.5
	Control	2,339	2,219.4	2,194.5	-24.9

Source: Analysis of individual student data from TEA.
Note. Students had TAKS scores in both 2004 and 2005. Students were in the same schools for TAKS testing in the spring of 2005 and for TEA's enrollment snapshot in the October 2004.

As a whole, TAKS passing rates and scale scores provide evidence of student progress toward meeting state standards—however, additional statistical analyses are necessary to determine the effects of immersion on student achievement.

Effects of Immersion on Sixth Graders' Achievement

The analyses that follow contrast the achievement of sixth-grade students in immersion and control schools before and after one academic year of implementation of the Technology Immersion Pilot. Immersion effects are estimated for sixth-grade TAKS reading and mathematics *z* scores. The *z* score provides an appropriate measure for making comparisons across grade levels and student groups. The effects of immersion on students' reading and mathematics *z* scores were analyzed using a two-level hierarchical linear model (HLM). HLM is a "value added" methodology. That is, after controlling for students' initial achievement and characteristics and accounting for variance at both the student and school level, researchers can assess the "value added" by a treatment.

Student-Level Model

In the student-level model, spring 2005 reading and mathematics *z* scores were regressed on spring 2004 reading and mathematics *z* scores, minority status (1 if Hispanic or African American, 0 if not), economic status (1 if economically disadvantaged, 0 if not), and gender (1 if female, 0 if male). That is,

$$Y_{ij} = \beta_{0j} + \beta_{1j}(\text{Spring 2004 z score}) + \beta_{2j}(\text{Minority status}) + \beta 3_j(\text{Economic status}) + \beta 4_j(\text{Gender}) + r_{ij.}$$

With both 2005 reading and mathematics scores, significant variation was found across schools. Specifically, 10% of reading variance and 14% of mathematics variance was between schools (see Table 7.5). Thus, the school means (β_{0j}) were specified as randomly varying. The coefficients for spring 2004 *z* scores (β_{1j}) were also specified as randomly varying (significant chi-square statistics). The coefficients for minority status, economic status, and gender were specified as fixed.

School-Level Model

A school-level model was developed to answer the question of whether immersed schools had higher achievement scores than control schools, after controlling for initial achievement and minority status, economic status, and gender. That is,

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(\text{Immersion dummy}) + \mu_{0j}.$$

The immersion dummy was an indicator variable with a value of 1 for an immersed school and a value of 0 for a control school. Descriptive statistics for these analyses are reported in Table 7.3. The results of the HLM analyses are reported in Tables 7.4 and 7.5. Findings show that:

- After controlling for spring 2004 reading *z* scores, minority status, economic status, and gender, there were no significant differences in the spring 2005 reading *z* scores of students in immersed schools and students in control schools.

- After controlling for spring 2004 mathematics *z* scores, minority status, economic status, and gender, there were no significant differences in the spring 2005 mathematics *z* scores of students in immersed schools and students in control schools.
- Net of spring 2004 reading scores, minority status, and economic status, females had higher spring 2005 reading scores than males.
- Net of spring 2004 scores, minority status, and gender, economically advantaged students had higher spring 2005 scores than economically disadvantaged students in both reading and mathematics.
- Net of spring 2004 scores, economic status, and gender, non-minority students had higher spring 2005 scores than minority students in both reading and mathematics.

Table 7.3. Descriptive Statistics for Sixth-Grade Achievement

Variable Name	*N*	Mean	*SD*	Minimum	Maximum
TAKS Reading (Student Level)					
Gender (1 = female, 0 = male)	4,285	0.51	0.50	0.00	1.00
Minority (1 = minority, 0 = not)	4,285	0.75	0.43	0.00	1.00
Eco. disadvantaged (1 = yes, 0 = no)	4,285	0.72	0.45	0.00	1.00
TAKS Reading *z* score (2004)	4,285	-0.13	0.98	-3.00	2.37
TAKS Reading *z* score (2005)	4,285	-0.26	0.98	-3.34	2.46
TAKS Mathematics (Student Level)					
Gender (1 = female, 0 = male)	4,329	0.51	0.50	0.00	1.00
Minority (1 = minority, 0 = not)	4,329	0.75	0.43	0.00	1.00
Eco. disadvantaged (1 = yes, 0 = no)	4,329	0.73	0.45	0.00	1.00
TAKS Mathematics *z* score (2004)	4,329	-0.09	0.95	-2.73	2.55
TAKS Mathematics *z* score (2005)	4,329	-0.25	0.91	-4.49	2.52
Campus-Level Descriptive Statistics					
Immersion status (1 = yes, 0 = no)	44	0.50	0.51	0.00	1.00

Table 7.4. Immersion (Fixed) Effect Analyses of Sixth-Grade Achievement

TAKS Achievement Test	School-Level Analysis	Gamma Coefficient	Standard Error	*t*-value
Reading				
	Base	-0.132	0.036	-3.66**
	Immersion dummy	-0.047	0.042	-1.13
	Spring 2004 score	0.699	0.019	37.44***
	Gender	0.150	0.018	8.30***
	Minority	-0.104	0.029	-3.59**
	Eco. disadvantaged	-0.115	0.035	-3.27**
Mathematics				
	Base	-0.084	0.046	-1.84
	Immersion dummy	-0.031	0.052	-0.60
	Spring 2004 score	0.695	0.022	31.83***
	Gender	0.030	0.019	1.58
	Minority	-0.090	0.021	-4.37***
	Eco. disadvantaged	-0.093	0.022	-4.14***

*$p < .05$; **$p < .01$; ***$p < .001$.

Table 7.5. Ancillary Statistics Related to the HLM Analyses of Sixth-Grade Achievement

Achievement	Intraclass Correlation or Proportion of Outcome Variation Between Schools[a]	Percentage of Variance Explained by the Student-Level Model[b]	Percentage of Variance Explained by the School-Level Model[c]
Reading	0.099	0.543	0.047
Mathematics	0.139	0.557	0.004

[a] The intraclass correlation measures the degree of dependence in the spring 2005 *z* scores among the students sharing a school. A value of 0 would indicate no need for a multilevel analysis.
[b] This is a measure of the proportion reduction in within-school variance computed by comparing the within-school variance from a null model (no predictors) with the within-school variance from the student-level model (fall 2004 *z* score, gender, minority status, and economic status as predictors).
[c] This is a measure of the proportion reduction in between-school variance computed by comparing the between-school variance from the level 1 or student-level model with the between-school variance from the school-level model (immersion indicator variable as the predictor).

In sum, results for HLM analyses revealed that although students at immersed schools had somewhat lower TAKS *z* scores in reading and mathematics, there were no statistically significant differences between groups. There were, however, differences between schools within the treatment and control groups and differences in student growth rates. These differences will be the focus of additional statistical analyses in future reports. In particular, we will explore differences for students nested within classrooms within schools (3-level HLM).