eTxTIP

Evaluation of the Texas Technology Immersion Pilot

Final Outcomes for a Four-Year Study (2004–05 to 2007–08)

January 2009

Prepared for
Texas Education Agency

Prepared by
Texas Center for Educational Research

TCER
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Texas Center for Educational Research
P.O. Box 679002
Austin, Texas 78767-9002
800.580.TCER (8237)
512.467.3632   512.467.3658 (fax)
tcer.org

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For additional information about TCER research, please contact:

Catherine Maloney, Director
Texas Center for Educational Research
12007 Research Blvd.
P.O. Box 679002
Austin, Texas 78767-9002
Phone: 512-467-3632 or 800-580-8237
Fax: 512-467-3658

Reports are available at www.tcer.org and www.etxtip.info

Contributing Authors

Shapley Research Associates, LLC
Kelly Shapley, Ph.D.

Texas Center for Educational Research
Daniel Sheehan, Ed.D.
Catherine Maloney, Ph.D.
Fanny Caranikas-Walker, Ph.D.

Prepared for

Texas Education Agency
1701 N. Congress Avenue
Austin, Texas 78701-1494
Phone: 512-463-9734

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Executive Summary

The Technology Immersion Pilot (TIP), created by the Texas Legislature in 2003, was based on the assumption that the use of technology in Texas public schools could be achieved more effectively by "immersing" schools in technology rather than by introducing technology resources, such as hardware, software, digital content, and educator training, in a cyclical fashion over time. The Texas Education Agency (TEA) invested more than $20 million in federal Title II, Part D monies to fund Technology Immersion projects at high-need middle schools through a competitive grant process. Concurrently, a research study partially funded by a federal Evaluating State Educational Technology Programs grant has investigated whether student achievement improved over time through exposure to Technology Immersion. The Texas Center for Educational Research (TCER) was TEA's partner for a four-year evaluation of the implementation and effectiveness of the Technology Immersion model. The study addressed five major research questions:

- What was the effect of Technology Immersion on teachers and teaching?
- What was the effect of Technology Immersion on students and learning?
- What was the effect of Technology Immersion on students' academic achievement?
- How well was Technology Immersion implemented, and
- What was the relationship between implementation and student academic outcomes?

Technology Immersion

State statute described Technology Immersion generally, but to advance consistent interpretation of Technology Immersion at schools, the TEA issued a Request for Qualifications for commercial vendors to apply to become providers of Technology Immersion packages. Vendors' plans had to include six components: (a) a wireless mobile computing device for each educator and student on an immersed campus; (b) productivity, communication, and presentation software; (c) online instructional resources supporting the state curriculum in English language arts, mathematics, science, and social studies; (d) online assessments to diagnose students' mastery of the core curriculum; (e) professional development designed to help teachers integrate technology into teaching, learning, and the curriculum; and (f) initial and ongoing technical support. Through an expert review process, the TEA selected three lead vendors to provide Technology immersion packages (Dell Computer Inc., Apple Computer Inc., and Region 1 Education Service Center [ESC]). Of the 21 Technology Immersion schools studied in the evaluation, 5 middle schools selected the Apple package, 15 selected the Dell package, and 1 school selected the Region 1 ESC package (with Dell computers).

The *Theoretical Framework for Technology Immersion* guided the evaluation. The framework postulated a linear sequence of causal relationships. First, treatment schools were to be "immersed" in technology through the introduction of Technology Immersion components. An improved school environment for technology was expected to produce teachers who were more technically proficient, used technology for professional productivity, had students use technology in their classes, and used laptops and digital resources to increase the intellectual rigor of lessons. In turn, changed school and classroom conditions were expected to improve students' technology proficiency, learning experiences, collaborative interactions with peers, personal self-direction, and engagement in school and learning. Changes in students and their learning experiences presumably contributed to increased academic performance as measured by standardized test scores. In the framework, prior student achievement and student, family, and school characteristics exerted their own influence on learning.

Methodology

The fourth-year evaluation provides final conclusions about the effects of Technology Immersion on schools, teachers, and students. This report combines information gathered during the fourth project year (2007-08) with data from the first-through-third implementation years (2004-05 through 2006-07). The study's quasi-experimental research design has allowed inferences about the causal effects of Technology Immersion through comparisons between 21 treatment schools and 21 control schools.

Setting and Participants

The 42 participating schools included Grades 6 to 8 middle schools drawn from rural, suburban, and urban locations across Texas. Middle schools were typically small (about 400 students, on average); however, enrollments varied widely (from 83 to 1,447 students). About two-thirds of schools were located in small or very small Texas districts (less than 3,000 students), and about a third were in very large districts (10,000 or more students). Students in the study were mostly economically disadvantaged (67%) and they were racially and ethnically diverse (roughly 58% Hispanic, 7% African American, and 36% White).

The study focused on three student cohorts in the fourth year. Cohort 2 included eighth graders (2,578 treatment and 2,858 control students) who finished their third immersion year; Cohort 3 included seventh graders (2,547 treatment and 2,845 control students) who concluded their second year. We also examined achievement data for Cohort 1 students (2,469 treatment students and 2,748 control-group students) who had attended Technology Immersion and control schools from sixth-through-eighth grade and then attended traditional high schools in the fourth year (high schools that typically did not provide individual laptops for students).

Data Collection and Analysis

Data came from qualitative and quantitative sources. Researchers conducted site visits at each of the middle schools in fall 2004 and again in spring 2005 through 2008. For this report, we concentrated on data gathered through observations in a sample of Grades 6, 7, and 8 classrooms (English language arts, mathematics, social studies, and science). Additional measures included annual online teacher surveys and student paper-and-pencil surveys. We also gathered school and student data on a yearly basis from the Texas Public Education Information Management System (PEIMS) and the Academic Excellence Indicator System (AEIS), as well as data on student disciplinary actions from individual schools. We used three-level hierarchical linear models (HLM) to analyze immersion effects on teachers' and students' perceptions of their technical proficiencies and technology use, and the effects of immersion on students' Texas Assessment of Knowledge and Skills (TAKS) scores. HLM growth modeling estimated the effects of immersion on rates of growth for dependent variables across time (2004, 2005, 2006, 2007, and 2008). Two-level HLM models were used to analyze associations between the strength of implementation and students' TAKS achievement.

Study Limitations

The study's quasi-experimental research design had good internal validity given that initially there were no statistically significant differences between the treatment and control schools. A threat to internal validity was introduced in the third and fourth years when control schools began to plan for Technology Immersion. Many control teachers received laptops, instructional resources, and intensive professional development in the third year, and in the fourth year, some students at control schools received laptops (about 260 or 9% of eighth graders and 480 or 17% of seventh graders). Thus, the introduction of Technology Immersion components in control schools may bias fourth-year results. Generalization of findings to a broader population (external validity) is another study limitation. Compared to Texas middle-school students overall, students in the sample schools were substantially more Hispanic and less White and African American. Middle schools were also smaller than the statewide average, and schools were located either in small or very small districts or large districts, which is different from the statewide distribution of schools. The study also relied on self-reported data from surveys of teachers and students, so some findings reflected respondents' perceptions. Nonetheless, the triangulation of evidence from multiple sources (surveys, classroom observations, state demographic and test databases, multiple student cohorts) verifies the robustness of findings. Researchers are reasonably confident that reported effects can be attributed to the treatment.

Major Findings

Like previous years, outcomes represented the effects of Technology Immersion for schools that generally reached less than full implementation. Major findings from the fourth year are described in the following sections. A final section discusses the quality of Technology Immersion implementation, prospects for sustainability of the model, and implications for educational policy.

Effects of Technology Immersion on Teachers and Teaching

Teachers in Technology Immersion schools grew in technology proficiency, their use of technology for professional productivity, and their use of technology for student learning activities at significantly faster rates than control teachers. Technology Immersion teachers were increasingly more technology proficient (i.e., technology operations and pedagogical skills), and they used technology more often for professional productivity purposes. However, as control teachers acquired more technology resources through immersion grants, differences between teacher groups narrowed. Nevertheless, teachers at Technology Immersion schools, who had greater classroom access to computers, increased the frequency of their students' Classroom Activities involving technology at a more rapid pace. Fourth-year averages showed that students used a variety of technology resources but each of the applications was used infrequently (i.e., about once or twice a month on average). Similar to previous years, English language arts, science, and social studies teachers had students use technology considerably more often than mathematics teachers.

Teachers at Technology Immersion schools expressed significantly stronger ideological associations across years with technology integration and learner-centered practices. Teachers at both immersion and control schools became more positive towards innovative technology practices across years, but immersion teachers altered their beliefs at a significantly faster rate. Thus, immersion teachers increasingly employed actions such as promoting students' authentic problem solving or critical thinking through technology, and they expressed increasingly stronger affiliations with learner-centered practices, such as having students establish individual learning goals and emphasizing experiential learning.

The introduction of Technology Immersion components in schools affected teachers' perceptions of the school's culture as well as the frequency of teachers' collegial interactions. Across the first two project years, teachers in immersion schools compared to control reported significantly stronger leadership for technology, parent and community support, culture of innovation, and collaborative interactions with colleagues. Differences between the views of treatment and control teachers dissipated in the third and fourth years after introducing technology resources in control schools. Control teachers who experienced aspects of Technology Immersion thought their schools' technology environments were more innovative and supportive. Still, teachers at Technology Immersion schools who had access to technology resources over a longer period of time had more frequent collaborative interactions with their colleagues that supported instructional practices involving technology.

Evidence from classroom observations suggested that laptop computers and digital resources allowed students in Technology Immersion schools to experience somewhat more intellectually demanding work. Observations of core-subject classes (English language arts/reading, mathematics, science, and social studies) revealed no statistically significant differences between the overall Intellectual Challenge of treatment and control teachers' instruction. However, effect sizes measuring instructional differences between groups generally showed positive effects favoring immersion teachers, especially for the domains measuring Higher Order Thinking (e.g., synthesizing, generalizing, explaining) and Depth of Knowledge (e.g., thorough exploration of a topic that produces complex understandings). Nevertheless, results for *all* observed teachers indicated that lessons in middle school core-subject classes generally failed to intellectually challenge students, with average fourth-year ratings of about 2 on the 5-point intellectual challenge scale.

Effects of Technology Immersion on Students and Learning

Economically advantaged and disadvantaged students in Technology Immersion schools became significantly more technology proficient than their counterparts in control schools. Economically disadvantaged immersion students reached proficiency levels that matched the skills of advantaged control students. Across implementation years and cohorts, students in Technology Immersion schools have made significantly greater progress in mastering the Texas Technology Applications standards than control students. Both economically advantaged and disadvantaged students in immersion schools grew in proficiency at faster rates than their control-group counterparts. Thus, economically disadvantaged students in Technology Immersion schools reached levels of technical proficiency that equaled the proficiencies of advantaged students in control schools.

Students in Technology Immersion schools used technology applications more often in their core-subject classes and they interacted more often with their peers in small-group activities. For Cohorts 2 and 3, the yearly growth rates in Classroom Activities for economically advantaged and disadvantaged immersion students ranged from 0.19 to 0.43 scale-score points (on a 5-point scale), compared to 0.10 to 0.21 points for comparable control-group students. Students in immersion schools also had more frequent collaborative learning experiences. Seventh and eighth graders in immersion schools reported increasing opportunities for small-group work with classmates, whereas their control-group peers reported less frequent small-group activities as they advanced to higher grade levels.

As laptops aged over four years, students at Technology Immersion schools, compared to control, reported more technical problems when they used computers at school. In the fourth year, students in Technology Immersion schools reported technical problems with computers at more than twice the rates reported by control students. Eighth graders (Cohort 2) and seventh graders (Cohort 3) who often inherited second-hand laptops and had used those laptops across school years reported significantly more technical problems than control group-students. Although various technical problems occurred rarely (a few times a year) or just sometimes (once or twice a month), problems with deteriorating laptops substantially increased the workloads of technical-support staff, who often were already overburdened with technical demands.

Across four evaluation years, there was no evidence linking Technology Immersion with student self-directed learning or their general satisfaction with schoolwork. Findings from three student cohorts across four evaluation years showed there was no statistically significant effect of Technology Immersion on student Self-Directed Learning, as measured by the *Style of Learning Inventory*. As both immersion and control students progressed from lower to higher grade levels, their responses to statements measuring self-direction (e.g., goal setting, self-efficacy beliefs, and intrinsic effort) revealed significantly negative growth trends. Similarly, there was no significant difference in the levels of satisfaction with schoolwork expressed by treatment and control students. Across *all* middle schools, students' became less satisfied with the meaningfulness and relevance of their schoolwork as they advanced to higher grade levels.

Across four years, students in Technology Immersion schools consistently had fewer disciplinary actions than control-group students. Disciplinary Action Reports submitted to the TEA for each student during the 2007-08 school year, similar to the previous three years, showed that immersion students had proportionately fewer disciplinary problems than their counterparts in control schools. In the fourth year, Cohorts 2 and 3 immersion students had an average of 0.54 and 0.45 disciplinary actions per student, respectively, compared to 0.76 and 0.71 per-student averages for control students. Effect sizes measuring the magnitude of differences between groups were small (-.11 to -.13). However, reducing disciplinary actions may have practically important benefits due to increased students who remained in classrooms, and decreased time and effort expended by middle school teachers and administrative staff in addressing the disciplinary problems of students removed from classrooms.

For the first-through-third evaluation years, students at Technology Immersion schools had significantly lower school attendance rates than control students—however, in the fourth year, attendance-rate differences between treatment and control students were smaller and statistically nonsignificant. Unexpectedly, students at Technology Immersion schools attended school *less* regularly than control students across the first three years. For example, in the third year, economically advantaged and disadvantaged Cohort 2 students had average attendance rates of 96.9% and 95.9% compared to 97.2% and 96.3% for their control-group peers. Cohort 2 students at immersion schools (who were eighth graders in the fourth year) continued to have slightly lower attendance rates (96.6% and 95.4% for economically advantaged and disadvantaged students, respectively) compared to their control-group counterparts (97.0% and 95.8%, respectively); however, differences between groups were extremely small and not statistically significant. Likewise, the attendance rate differences between Cohort 3 treatment and control students were very small and statistically insignificant in the fourth year. It is possible that the introduction of laptops in some control schools during the fourth year may have had a slightly negative effect on students' school attendance rates (similar to the lower attendance of immersion students). Nevertheless, contrary to what might be expected, immersion students' modestly lower average school attendance rates were not associated with lower academic achievement.

Effects of Technology Immersion on Academic Achievement

For analyses of student achievement involving comparisons across grade levels, TAKS scale scores were standardized as *T* scores with a mean of 50 and standard deviation of 10. We used three-level HLM models to estimate the effects of Technology Immersion on students' test scores for Cohort 2 (eighth graders) and Cohort 3 (seventh graders). We also investigated the TAKS performance of Cohort 1 students (ninth graders) who attended Technology Immersion and control schools and then attended mostly traditional high schools through TAKS testing in spring 2008. The table below summarizes the estimated magnitude of the Technology Immersion effect on TAKS reading and mathematics achievement across student cohorts. HLM model-based estimations of effects are described as the cumulative growth in *T*-score units for Technology Immersion and control groups, the mean cumulative growth differences between groups in *T*-score units, and the estimated sizes of the effects in standard deviation units. Major findings for TAKS achievement follow the table.

HLM Model-Based Estimations of Technology Immersion Effects on TAKS scores by Subject, Economic Disadvantage Status, and Student Cohort

Assessment/Student Cohort	Cumulative Growth: Immersion *T*-score Growth	Cumulative Growth: Control *T*-score Growth	Cumulative Growth: Mean *T*-score Difference	Standard Deviation Units
TAKS Reading, Advantaged				
Cohort 1: 9th graders, post-immersion	0.76	-0.06	0.81†	0.08
Cohort 2: 8th graders, 3 immersion years	1.10	0.39	0.70	0.07
Cohort 3: 7th graders, 2 immersion years	0.00	-0.21	0.21	0.02
TAKS Reading, Disadvantaged				
Cohort 1: 9th graders, post-immersion	2.22	1.41	0.81†	0.08
Cohort 2: 8th graders, three immersion years	2.02	1.32	0.70	0.07
Cohort 3: 7th graders, two immersion years	0.22	0.01	0.21	0.02
TAKS Mathematics, Advantaged				
Cohort 1: 9th graders, post-immersion	2.14	0.88	1.25	0.13
Cohort 2: 8th graders, 3 immersion years	1.27	-0.69	1.96*	0.20
Cohort 3: 7th graders, 2 immersion years	0.74	-0.83	1.57*	0.16
TAKS Mathematics, Disadvantaged				
Cohort 1: 9th graders, post-immersion	1.63	0.38	1.25	0.13
Cohort 2: 8th graders, three immersion years	1.81	-0.15	1.96*	0.20
Cohort 3: 7th graders, two immersion years	0.09	-1.48	1.57*	0.16

Note. Estimated *T*-score growth for students attending schools with average levels of poverty. Cumulative growth in *T*-score units (mean= 50, standard deviation = 10). Standard deviation units = *T*-score difference/10. Cumulative growth for Cohorts 1, 2, and 3 accounted for growth across four, three, and two years, respectively.
†$p < .10$. *$p < .05$.

Technology Immersion had no statistically significant effect on TAKS reading achievement for Cohort 2 (eighth graders) or Cohort 3 (seventh graders)—however, for Cohort 1 (ninth graders), there was a marginally significant and positive sustaining effect of Technology Immersion on students' TAK reading scores. After controlling for student and school poverty, there were no statistically significant effects of immersion on the TAKS reading growth rates for either Cohort 2 or Cohort 3. The immersion effects were positive but not by statistically significant margins. For Cohort 1 there was a statistically significant and positive sustaining effect of immersion on the TAKS reading growth rates of ninth graders who had attended immersion middle schools and then moved on to mainly traditional high schools ($p < .06$). The reading achievement of post-immersion students increased by 0.19 *T*-score point per year (0.76 cumulative growth over four years), whereas the achievement of control ninth graders decreased by about 0.01 *T*-score point per year (-0.06 cumulative growth). Across Cohorts 1 and 2, economically disadvantaged students grew in reading achievement at significantly faster rates than their more affluent peers. For TAKS reading, the sizes of immersion effects in standard deviation units (.08, .07, and .02) were very small but increased with longer exposure to Technology Immersion and through the post-immersion year in high school.

Technology Immersion had a statistically significant effect on TAKS mathematics achievement for Cohort 2 (eighth graders) and Cohort 3 (seventh graders). For Cohort 1 (ninth graders), the sustaining effect of immersion on TAKS mathematics scores was positive but not by a statistically significant margin. After controlling for student and school poverty, estimated yearly TAKS mathematics growth rates for economically advantaged students in immersion schools (0.42 and 0.37 *T*-score points per year for Cohorts 2 and 3, respectively) significantly outpaced their control-group counterparts (-0.23 and -0.42 *T*-score points, respectively). Similarly, estimated yearly TAKS growth rates for economically disadvantaged students in immersion schools (0.60 and 0.05 *T*-score points per year for Cohorts 2 and 3, respectively) were significantly more positive than their control-group counterparts (-0.05 and -0.74 *T*-score points, respectively). There were no statistically significant differences between the TAKS mathematics outcomes for Cohort 1 post-immersion and control-group ninth graders. For TAKS mathematics, the sizes of immersion effects in standard deviation units for Cohort 2 (.20) and Cohort 3 (.16) were small but statistically significant ($p < .05$). The estimated immersion effect for Cohort 1 ninth graders in standard deviation units (0.13) was similar to the magnitude of the effect detected at the end of their eighth-grade year.

Similar to the previous year, students' use of their laptops for Home Learning—a measure of the extent to which a student used a laptop outside of school for homework in the four core-subject areas or for learning games—was the strongest implementation predictor of students' TAKS reading and mathematics scores. Given variations in the quality of implementation of Technology Immersion across schools, classrooms, and students, two-level HLM models with students nested within reading and mathematics teachers were used to examine the relationship between implementation and student achievement. Controlling for student characteristics and prior achievement, and other variables in the analysis, a composite measure of Student Access and Use (Laptop Access Days, Core-Content Learning, and Home Learning) was a consistently positive although not always statistically significant predictor of students' TAKS reading and mathematics scores for Cohorts 2 and 3. Of the three elements of Student Access and Use, students' use of laptops for Home Learning was the strongest predictor of both TAKS reading and mathematics achievement. For Cohort 2, the extent of Home Learning was a positive but statistically nonsignificant predictor of TAKS reading scores and a positive and marginally significant predictor of TAKS mathematics scores. For Cohort 3, the extent of Home Learning was a positive and statistically significant predictor of both TAKS reading and mathematics scores.

The findings for Home Learning underscore the important role that individual student laptops play in promoting ubiquitous learning and in equalizing the out-of-school learning opportunities for students in disadvantaged family and school situations. Individual student laptops, in contrast to laptops on carts or computers in libraries, labs, or classrooms, expand where and how student learning occurs. However, schools and teachers also played an important role. In a third-year study, researchers found that teachers at higher Technology Immersion schools encouraged students' use of laptops outside of school by engaging students in projects or assignments that motivated students to continue working outside of class. Also, access to electronic textbooks on laptops motivated many students to continue working on chapter assignments outside of school (Shapley et al., 2008).

Conclusions about the effects of Technology Immersion on TAKS social studies and science scores remain in doubt. However, outcomes for TAKS writing, which involved the administration of the TAKS assessment in traditional paper-and-pencil format, have consistently favored control students although not by statistically significant margins. Since TAKS tests for social studies, science, and writing are not administered annually, immersion effects for those subject areas cannot be replicated across cohorts and years. Accordingly, it is difficult to draw definitive conclusions about the effects of Technology Immersion for these subject areas. Available results have revealed no statistically significant differences between treatment and control groups for TAKS social studies, science, or writing scores. Treatment-control group differences for science and social studies have varied from year to year, whereas outcomes for TAKS writing have consistently favored students at control schools. Across evaluation years, seventh graders in immersion schools, on average, have had lower TAKS writing scores (-0.91, -0.28, and -0.73 *T*-score points for Cohorts 1, 2, and 3 students, respectively). Even so, it is possible that the administration of the TAKS assessment in paper-and-pencil format may underestimate the writing performance of Technology Immersion students who have used word processing software on a regular basis for written schoolwork. Some research studies have shown that traditional assessments misjudge the writing performance of students who are accustomed to using word processors for writing and are not allowed to use word processors when tested (Russell & Haney, 1997; Russell & Plati, 2001).

Nature of Fourth-Year Implementation

The overall level of implementation of the Technology Immersion model increased to some extent across years—even so, just a quarter of schools reached substantial levels of immersion by the end of the fourth implementation year. Implementation of the Technology Immersion model requires Leadership, Teacher Support (buy-in), Parent and Community Support, Technical Support, and Professional Development. Given adequate supports, teachers should reach high levels of Classroom Immersion, and Student Access and Use of technology should be robust. Mean immersion standard scores showed small yearly increases across most implementation support components and increases in teachers' levels of Classroom Immersion. In contrast, the level of Student Access and Use declined across years. Mean fourth-year standard scores (ranging from 2.69 to 3.19 on a 4-point implementation scale) showed that many schools needed stronger supports, especially in the areas of parent and community support for technology use, technical supports that addressed obstacles to technology use, and professional development for teachers.

Core-subject teachers at the majority of schools reported only partial levels of Classroom Immersion in the fourth year. Teachers' mean scores at a fifth of schools, however, revealed substantial levels of Classroom Immersion. As a whole, standards-based implementation scores for Classroom Immersion increased slightly across years (from 2.48 to 2.69 on a 4-point scale). Scores for four of the five elements of Classroom Immersion showed somewhat stronger implementation in the fourth year, with the largest increase for teachers' use of technology for their own purposes (Professional Productivity) and the smallest change for classroom integration (Technology Integration). The frequency with which teachers allowed students to use technology for learning activities (Student Activities) remained relatively stable across years.

Students' access to and use of laptops for learning within and outside of school continued to fall well short of expectations in the fourth year. The percentages of schools with at least *partial* levels of Student Access and Use decreased across three years (76%, 68%, and 57%), while the percentages of schools with *minimal* student access and use increased (24%, 32%, and 43%). Several factors affected students' opportunities to use laptops for learning within classrooms and outside of school. These factors mainly included time lost for repairs due to aging laptops, schools that opted to transfer laptops from individual students to carts or classroom sets, schools that restricted students' use of laptops outside of school, and teachers' preferences regarding classroom laptop use. Year-to-year comparisons showed that the mean implementation level for Laptop Access Days increased between the third-and-fourth implementation years (from 2.50 to 2.64 on a 4-point scale) due to more consistent student "access" to laptops (although not "ownership") on carts or as classroom sets at some schools. At the same time, the yearly mean implementation levels for Core-Content Learning (classroom laptop use) decreased across years (2.07, 2.12, and 1.95) and laptop use for Home Learning, likewise, decreased over time (1.75, 1.84, and 1.63). These trends replicate what other researchers have documented. When teachers are the "gatekeepers" of technology use, many teachers, especially veterans, will opt to continue traditional practices and reject practices that require innovation and instructional change (Cuban, 2002; Russell, Bebell, & Higgins, 2004).

Implementation and Sustainability

Implementation Fidelity of the Technology Immersion Model

During spring 2008 site visits at schools, researchers asked principals, technology specialists, and teachers to describe their progress in implementing Technology Immersion, and in retrospect, what they would have done differently to improve implementation.

Nearly all of the Technology Immersion Pilot (TIP) grantees said the lack of a start-up year for planning was a major barrier to effective implementation of Technology Immersion. The majority of middle schools received their TIP grant awards just before the start of the first project year. Thus, many thought implementation would have progressed more smoothly if there had been a start-up year to plan for immersion. Respondents said a planning year would have allowed them to (a) have conversations with teachers about the decision to become an "immersed school," (b) develop a plan for managing laptops (especially at campuses with larger enrollments), (c) build the school's infrastructure for wireless technology, (d) have teachers become more accustomed to laptops and available software and digital resources, (e) provide professional development for teachers to strengthen their technical skills and ability to plan technology-integrated lessons, and (f) give teachers a chance to "try out" lessons with laptops.

TIP grantees who were more successful thought that committed leaders, thorough planning, teacher buy-in, preliminary professional development for teachers, and a commitment to the transformation of student learning were keys to their successful implementation of Technology Immersion. Respondents at some schools attributed effective implementation to several factors. Foremost, despite a quick start, district and school administrators had a well-conceived plan for implementation, were excited about the project, and listened to teacher input. Administrators had "high expectations" for technology use, but they allowed time for teachers to become comfortable. Professional development typically began before the first year started and was ongoing across implementation years. These schools also had collegial cultures, with teachers saying they learned from other teachers, "were all in this together," and "were willing and ready to try" new practices. Improvement of students' learning experiences drove higher quality implementation. Despite myriad laptop management issues, respondents believed challenges had been worthwhile because one-to-one student laptops and digital resources had increased the depth of learning across subject areas, exposed students to more real-life experiences, and allowed students to demonstrate greater responsibility.

Many TIP grantees reported that administrative turnover, noncommittal teachers, insufficient professional development, inadequate school infrastructures, and laptop management problems were impediments to effective implementation of the Technology Immersion model. Respondents at many schools cited obstacles that derailed their implementation efforts. At many schools, constant principal turnover caused major set-backs each year and undermined teacher buy-in for immersion. Many teachers expressed noncommittal attitudes about Technology Immersion at their schools, which seemed to stem from four main sources: (a) frustrations caused by the concurrent distribution of laptops to teachers and students in the first year, (b) the insufficiency of their preparation to meet technical demands and manage technology-integrated lessons, (c) students' inconsistent access to laptops for classroom activities, and (d) uncertainty about their students' capacity to handle one-to-one laptop access (i.e., students were too young or immature, lacked sufficient technical and keyboarding skills, had insufficient prior experience with computers, behaved irresponsibly with expensive laptops, or wanted to use technology to "play" rather than "learn"). Many teachers wished that professional development had been provided earlier, and that the training received had focused on content-specific lesson plans. Teachers new to schools often felt unprepared to deal with laptops in classrooms. Additionally, respondents at these schools often cited problems with inconsistent wireless Internet services, insufficient technical staff to deal with laptop repairs in a timely manner, and students who did not bring their laptops to school or class regularly.

Sustainability of the Technology Immersion Model

As part of site visits, administrators, technology specialists, and teachers also commented on sustainability of the Technology Immersion model at their schools.

Sustainability depended on the commitment of district leaders to Technology Immersion and to long-range planning for continuation. Principals and technology specialists at many campuses had not been directly involved in planning for the sustainability of Technology Immersion beyond the fourth year, and in fact, most said that decisions about continuation would rest with district administrators. At other campuses, plans were in place to continue Technology Immersion at middle schools, and some districts were planning to expand one-to-one computing to high schools or upper elementary grades. Respondents who described explicit plans for continuation cited the key roles of the superintendent and board of trustees. Sustainability of Technology Immersion depended on planning ahead and being prepared for future years, including actions such as having a plan for the replacement of worn and outdated laptops, allocating resources to support continuous teacher professional development, and allocating resources to provide technical support.

Sustainability of Technology Immersion depended on the adequacy of funds to support continuation. With TIP funds ending, many campuses were uncertain how Technology Immersion could be sustained financially. Given limited local and state dollars for technology, most respondents hoped to win additional grant awards to continue their one-to-one laptop programs. Many principals were optimistic about their chances of securing grants to support continuation but had doubts about receiving financial support from their districts or the state. A few districts and schools, however, had used local funds to support Technology Immersion and were considering how local funds could support continuation. Continuation at one school depended on a local bond issue. If the bond failed, there would be no money for laptops because budget shortfalls had caused cuts in administrative and teaching positions, so there was little hope of receiving district money for technology.

One district had invested substantial local funds to sustain immersion in the middle school and to expand one-to-one laptop access into the high school. Although the district was relying on local funds, the superintendent believed the state should provide more or more flexible financial support. In particular, state funding allocations earmarked by lawmakers for specific programs prevented local education agencies from combining state and local funds for school-reform initiatives. Additionally, several respondents thought the state should provide additional technology funding so that schools did not have to depend entirely on local funds. Having sufficient local funds was an acute problem for a property-poor district that depended on state funds and grants to purchase technology, but frequently did not qualify for grants due to high TAKS scores. One respondent said the continuation of Technology Immersion simply “depended on how much money the state legislature makes available to schools.” A few administrators believed traditional paper textbooks are outmoded and state funds invested in printing and delivering millions of textbooks across the state should be used to fund technology.

For some campuses, the TIP project was just another grant program, and once funding ended, the TIP project would disappear. Some principals said they would “love to continue immersion” but saw no way to financially sustain the current model. One principal said Technology Immersion is only sustainable in an “ideal world.” Another administrator said, “If the grant is not renewed, it would be the end of one-to-one computing.”

Sustainability of Technology Immersion was associated with educators' beliefs about technology's value for addressing the learning styles and needs of students, and educators' commitment to move toward digital school environments. School leaders who wanted to continue one-to-one laptop projects often linked their intentions with hopes for student learning. Administrators cited goals that involved moving students "away from drill and practice" and toward "creation of products"; preparing students for the 21st century; expanding learning outside of school; exposing students to "worldwide cultures"; and making learning "more than regurgitating information back on a test." Other campuses were committed to continuation of Technology Immersion because administrators saw the value of being "paperless." This involved purchasing electronic versions of textbooks (on CDs or online), conducting student assessments online, providing online college coursework and virtual learning opportunities for students, and reducing personnel costs through shared teachers for coursework delivered via videoconferencing. Some administrators said they simply could not "imagine being without laptops." "We would be stepping back in time," said one respondent.

Some school administrators were committed to continuation of Technology Immersion, but they wondered if an incremental approach to implementation might have improved their long-term prospects for sustainability. Some principals, especially those at larger schools, were committed to the full immersion model, but they thought it might be easier to move gradually toward full implementation of Technology Immersion by introducing student laptops gradually, immersing one grade at a time. One administrator, however, explained that the ultimate goal should be school-wide implementation because everyone "…is on the same page. It is a campus initiative, so the conversations are not just horizontal, it is vertical as well. That's the power of it…And the electives, it is across the board a whole-campus initiative."

Several schools that had great difficulty implementing the Technology Immersion model planned to abandon one-to-one student laptop access and return to more conventional configurations of educational technology. Some schools that experienced severe problems implementing Technology Immersion were considering other options for providing student access to technology. For example, one-to-one computing would be sustained only at selected grade levels, student access to laptops would be restricted to in-school use, laptops would be distributed as classroom sets, or laptops would be put on mobile carts for teacher checkout. Some teachers believed classroom sets of laptops instead of individual student laptops would minimize laptop "wear and tear" and "ensure that all students have a laptop" in class. Decisions to move toward more traditional technology configurations were typically intended to prolong the life of laptops.

Findings from four years suggest that Technology Immersion can be implemented and is sustainable if districts and schools are committed to the model—however, other approaches to technology use may be appropriate for some districts and schools. Over four years, it became evident that Technology Immersion involved more than just buying laptops for students. Technology Immersion is a comprehensive model for transforming the school culture, and the nature of teaching and learning, and expanding the educational boundaries of the school. This study shows that fundamental school change is difficult and requires a long-term commitment at all levels of the school system (board members, superintendent, principals, teachers, students, and parents). Given the financial and logistical challenges of implementing and sustaining the Technology Immersion model, statewide implementation may not be possible. However, those districts and schools that are committed to Technology Immersion should have state support for their innovative school-reform efforts. At the same time, other districts and schools should receive support for alternative technology initiatives that have research-based evidence of effectiveness.

1. Introduction

Technology Immersion arose as a comprehensive model that would counter the gradual way in which most Texas schools have introduced technology into the educational process and change the use of technology for teaching and learning in Texas classrooms (Texas Education Agency, 2006). The Technology Immersion Pilot (TIP), created by the Texas Legislature in 2003, set forth the vision for Technology Immersion in public schools. Senate Bill 396 called for the Texas Education Agency (TEA) to establish a pilot project to "immerse" schools in technology by providing a wireless mobile computing device for each teacher and student, technology-based learning resources, training for teachers to integrate technology into the classroom, and support for effective technology use. The TEA has used more than $20 million in federal Title II, Part D monies to fund Technology Immersion projects for high-need middle schools through a competitive grant process. Concurrently, a research study, partially funded by a federal Evaluating State Educational Technology Programs grant, has evaluated whether student achievement improved over time as a result of exposure to Technology Immersion. The Texas Center for Educational Research (TCER)—a non-profit research organization in Austin—has been the TEA's primary partner for this four-year evaluation that spanned the 2004-05 through 2007-08 school years.

Theory of Technology Immersion

The vision for educational technology endorsed by many educators, leaders, and policymakers has shifted over time from the use of particular technology hardware and software products to technology's incorporation into every aspect of the educational environment. Changing views reflect our growing understanding of how students learn and how to create environments that enhance teaching and learning. Cognitive science and other research reveal that children learn more when they are engaged in meaningful, relevant, and intellectually stimulating work (Bransford, Brown, & Cocking, 2003; Newmann, Bryk, & Nagoaka, 2001). Many believe that technology can support such learning experiences and also enable students to develop competencies needed for the 21st century, such as digital literacy, inventive thinking, and effective communication (CEO Forum, 2001; Lempke, Couglin, Thadani, & Martin, 2003; Partnership for 21st Century Skills, 2006).

Similarly, Texas recognizes that the state's long-term success is tied to the preparation of students for the digital age. The Texas *Long-Range Plan for Technology, 2006-2020*, advances the previous state plan for the integration of technology within schools across four domains: teaching and learning; educator preparation and development; leadership, administration, and instructional support; and infrastructure for technology (TEA, 2006). Senate Bill 396 further defined this comprehensive plan as Technology Immersion. Consistent with the overall Texas vision for technology, the long-term aspiration for Technology Immersion is to "prepare each student for success and productivity as a lifelong learner, a world-class communicator, a competitive and creative knowledge worker, and an engaged and contributing member of an emerging global society" (TEA, 2006, p. viii).

While state statute provided a general description of Technology Immersion, school-based implementation of the intervention required additional detail. In specifying the critical components of the immersion model, TEA staff considered current research on educational technology as well as practical wisdom gained through pilot studies and statewide technology initiatives. Technology Immersion assumes that effective technology use in schools and classrooms requires robust technology access, technical and pedagogical support for implementation, professional development for educators in using technology effectively, and readily available curricular and assessment resources that support the state's foundation curriculum (English language arts, mathematics, science, and social studies).

Purpose of the Study

The overarching purpose of this study was to scientifically investigate the effectiveness of Technology Immersion in increasing middle school students' achievement in core academic subjects as measured by the Texas Assessment of Knowledge and Skills (TAKS). The evaluation has also examined the relationships among contextual conditions, Technology Immersion, intervening factors (school, teacher, and student), and student achievement. The research design is quasi-experimental with 42 middle schools assigned to either treatment or control groups, with 21 schools in each. This report combines information gathered during the 2007-08 school year with information collected during the previous three school years to answer the following evaluation questions:

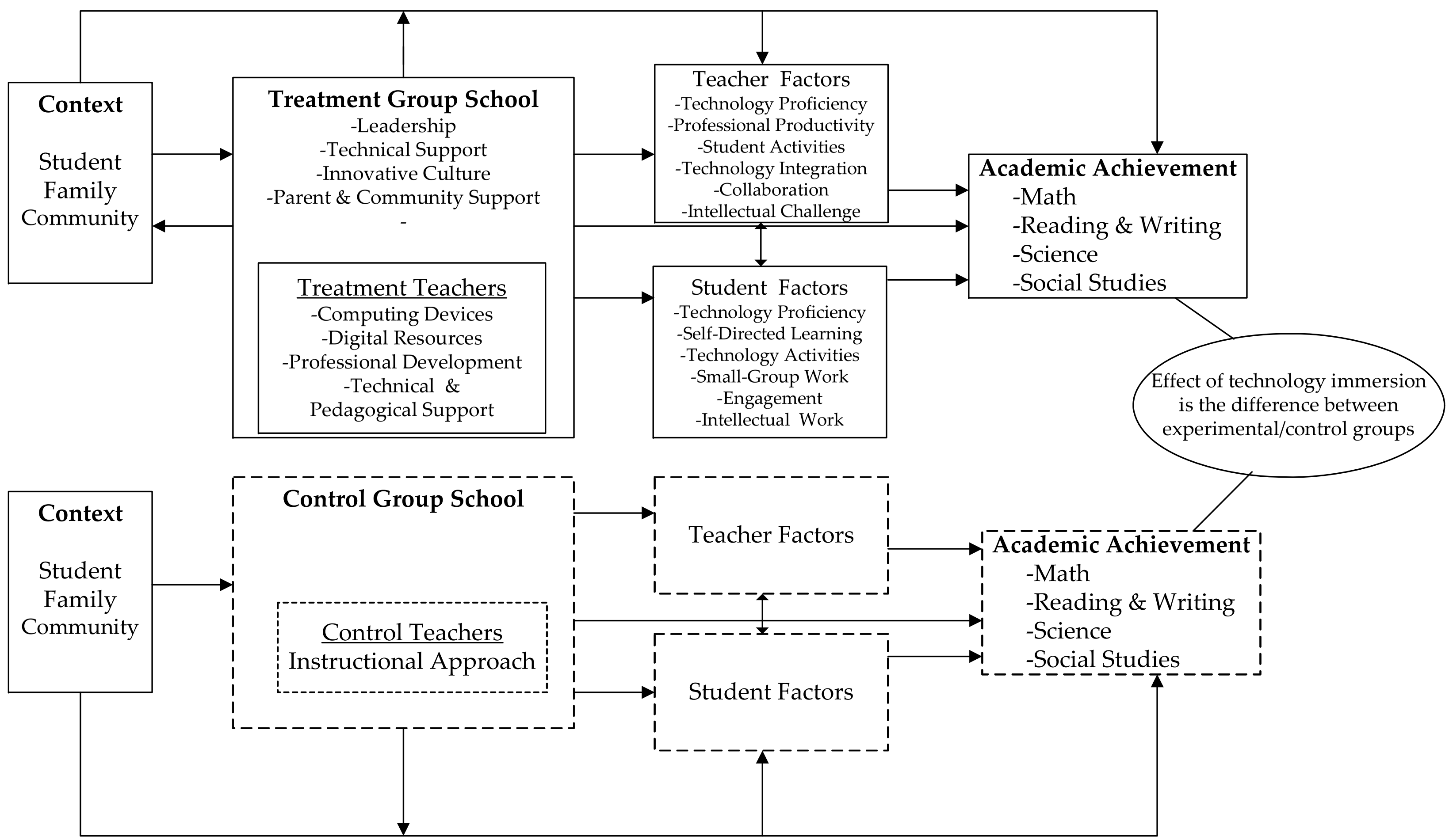
- How was Technology Immersion implemented,
- What was the effect of Technology Immersion on teachers and teaching,
- What was the effect of Technology Immersion on students and learning,
- Did Technology Immersion affect student achievement, and
- What factors were associated with implementation and student outcomes?

Theoretical Framework for Technology Immersion

The *Theoretical Framework for Technology Immersion* has guided the evaluation (see Figure 1.1). The experimental design, as illustrated in the framework, allowed researchers to estimate of the effects of Technology Immersion, which is the difference between the treatment and control groups. We also postulated a linear sequence of causal relationships. Program implementation comes first. Experimental schools are to be "immersed" in technology through the introduction of Technology Immersion components. The quality of implementation reflects the robustness of wireless laptop access for teachers and students, the adequacy of technical and pedagogical support services to maintain an immersed campus, the extent to which professional development supports curricular integration of technology, and how well curricular resources and assessments are used.

Given quality implementation, we theorized that an improved school environment for technology would then lead to teachers who had greater technology proficiency, had students use technology more and in new ways in their classrooms, and used laptops and digital resources to increase the intellectual challenge of lessons. In turn, these improved school and classroom conditions would lead students to greater technology proficiency, more frequent classroom technology activities, more opportunities for peer collaboration, greater 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 also are shown between student achievement and student, family, and school characteristics, which exert their own influence on learning. The research literature underpinning the Technology Immersion model and the theoretical framework is included in Appendix A.

Figure 1.1. Theoretical Framework for Technology Immersion



Organization of the Report

Data collection in the fourth project year (2007-08) involved a mix of quantitative and qualitative data sources. Researchers have annually conducted online teacher surveys and student paper-and-pencil surveys. We also have gathered school and student data on a yearly basis from the Texas Public Education Information Management System (PEIMS), the Academic Excellence Indicator System (AEIS), as well as data on student disciplinary actions from schools. Additionally, researchers have visited each of the middle schools in fall 2004 and again in spring 2005, 2006, 2007, and 2008. For this report, we include data from observations in a sample of grades 6, 7, and 8 core-subject classrooms.

Report sections are organized around findings relative to the study's research questions. An overview of report chapters is provided below.

- *Chapter 1, Introduction,* provides background on the Technology Immersion project as well as the study's theoretical framework. The chapter also establishes the purpose for the study and the research questions addressed.
- *Chapter 2, Methodology,* presents information on the evaluation design, characteristics of treatment and control schools, study limitations, study participants, data collection methods, and data analysis procedures.
- *Chapter 3, Technology Immersion—Fourth-Year Implementation,* describes progress toward implementation in the fourth year and compares the level of implementation across years.
- *Chapter 4, Effects of Technology Immersion on Teachers and Teaching*, presents findings on the effects of immersion on teacher variables, including technology knowledge and skills, ideology, student classroom activities and peer collaboration, and the intellectual challenge of lessons.
- *Chapter 5, Effects of Technology Immersion on Students and Learning*, offers findings on the effects of immersion on mediating variables, including students' experiences with technology; their self-perceptions of technology proficiency, self-directed learning, and school satisfaction; and their engagement in school and learning.
- *Chapter 6, Effect of Technology Immersion on Student Achievement*, presents findings on the effects of Technology Immersion on academic achievement, as measured by TAKS reading, mathematics, writing, science, and social studies.
- *Chapter 7, Factors Associated with Implementation and Outcomes,* presents results for investigations of the associations between implementation and student academic achievement.
- *Chapter 8, Conclusions and Implications*, presents the major findings from the study and discusses the implications of outcomes.

2. Methodology

Evaluation Design

The evaluation design is quasi-experimental. Interested districts and associated middle schools responded to a Request for Application (RFA) offered by the Texas Education Agency (TEA) to become Technology Immersion Pilot (TIP) schools. Applicants 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. Two middle schools from one district (one treatment and one control) were removed from analyses in the second year due to damage caused by Hurricane Rita. Thus, fourth-year results are for 21 treatment and 21 control schools. A re-analysis of baseline data for the new comparison groups revealed no statistically significant differences between school and student characteristics. Thus, the study's research design remained sound.

Treatment Sample

In spring 2004, the TEA released a series of RFAs inviting school districts to apply for TIP grants for up to two middle schools. The agency held an external review of proposals, with applications scored and rank ordered. Following the external review, researchers and agency staff reviewed proposals to ensure that applications met criteria established for Technology Immersion. Final selection of TIP schools involved the consideration of several factors, including proposal ratings, size, location, student diversity, and academic achievement. Decisions were influenced by the need for geographic distribution and the availability of comparable schools for the control group pool. Schools received grants to support the implementation of Technology Immersion for four school years.

Control Sample

The selection of control campuses first involved the generation of a pool of grades 6 to 8 middle schools eligible to receive federal funds for participation in the study. 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 software procedures to establish parameters around each variable of interest and the creation of a computer-generated list of "best matches" for each treatment school. The final selection 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.

For the first two evaluation years, each control school received $25,000 annually for study participation, with 25% of funds earmarked for professional development as required by Title II, Part D guidelines. At the end of the second year, the TEA offered delayed intervention grants that allowed control schools to begin planning for Technology Immersion. Of the 21 control schools included in analyses, 16 (76%) applied for and received TIP start-up grants. Grant guidelines allowed control schools to begin planning for Technology Immersion in the third year (2006-07); teachers could also receive laptops and instructional resources, and schools were required, as in previous years, to use 25% of funds for professional development. In the fourth year (2007-08), schools could provide laptops for students. Across the 16 control schools, three schools provided laptops for students in grades 6, 7, and 8, six schools provided laptops for students in grade 6, four schools provided laptops for students in grade 7, two schools provided laptops for students in grade 8, and one school provided laptops for students in grades 7 and 8. Control schools that declined Technology Immersion grants continued to receive $25,000 annually for study participation.

Characteristics of Participating Schools

The fourth-year study includes 42 grades 6 to 8 middle schools, including 21 treatment and 21 control schools drawn from rural, suburban, and urban locations in Texas. Middle schools are typically small, with more than three-quarters enrolling 600 students or fewer. Schools are highly concentrated in small or very small districts (2,999 or less students) across the state, but a third of schools are in large districts (10,000 or more students). There are two campus charter schools (one treatment and one control) located in a large urban district.

Results for *t*-tests at baseline 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 (Table 2.1). Likewise, results for student enrollment, mobility, and TAKS passing rates show no significant differences. Consequently, the treatment and control schools are sufficiently well matched on key demographic and academic performance measures. Additionally, both treatment and control groups include a comparable range of campus and district enrollments and schools from diverse regions. (See additional statistics in Appendix B.)

Table 2.1. Comparison of Baseline Characteristics: Technology Immersion (*N* = 21) and Control Schools (*N* = 21)

				95% Confidence Interval for Difference		
Variable	Condition	Mean	*SD*	Lower	Upper	*t* (40)
Enrollment	Immersion	374.9	348.4	-284.6	177.5	-0.47
	Control	428.5	391.3			
Economic disadvantage (%)	Immersion	70.8	17.5	-3.4	19.4	1.42
	Control	62.8	19.0			
Minority (%)	Immersion	68.1	28.4	-10.4	24.7	0.83
	Control	60.9	27.8			
ESL (%)	Immersion	13.5	17.2	-1.6	16.0	1.66
	Control	6.3	9.9			
Special education (%)	Immersion	14.7	5.5	-4.0	1.8	-0.76
	Control	15.8	3.7			
Student mobility (%)	Immersion	15.8	4.6	-3.8	2.8	-0.30
	Control	16.3	5.9			
TAKS 2004, Passing All (%)	Immersion	52.4	15.7	-9.2	8.5	-0.08
	Control	52.8	12.5			
TAKS 2003, Passing All (%)	Immersion	65.9	11.4	-9.1	5.5	-0.50
	Control	67.6	12.0			

Source: Texas Education Agency AEIS reports 2004
Note. TAKS = Texas Assessment of Knowledge and Skills. Differences between groups are statistically insignificant. Two campuses (one treatment and one control) were excluded from the groups in the second year.

Considering baseline statistics, the sample selection process and matching procedures appear to have produced a 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 somewhat higher percentages of minority, economically disadvantaged, and limited English proficient students could affect outcomes given known links between disadvantaged status and lower achievement (Sirin, 2005). Another threat to internal validity was introduced in the third project year when control schools began to implement elements of the treatment. As noted above, control schools began to plan for Technology Immersion in the third year, and most of the control teachers received new laptops and instructional resources. And, while teachers at control schools had opportunities for technology-related professional development during the first two project years, the emphasis intensified in the third and fourth years as schools purchased technology-related professional development services from vendors (Dell/Pearson Learning Group and Apple). The provision of laptops for students at the control schools introduced another Technology Immersion component that could contribute to an underestimation of the magnitude of the treatment effect in the fourth year. In particular, records submitted by schools indicated that about 260 eighth graders (9%) and 480 seventh graders (17%) at control schools received individual laptops during the fourth year.

Another 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 large proportions of children from families living in poverty[1] and middle schools with grades 6 to 8. 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 representative of the average middle school in Texas.

A majority of students in the sample are economically disadvantaged, with about 67% of sample students qualifying for federal free or reduced-price lunch compared to 51% for middle schools statewide. Sample schools include substantially more Hispanic and fewer White and African American students than state averages for middle schools. Overall, about 58% of sample students are Hispanic compared to about 37% of Texas middle school students. Conversely, the sample includes fewer African American students (7% vs. 14%) and White students (36% versus 46%) compared to the state averages. The sample schools also differ structurally from Texas middle schools as a whole. Middle schools in Texas, on average, enroll more students (667 vs. 402 in sample schools). Sample schools are located either in small or very small districts or large districts, whereas state middle schools are distributed across very small or small, mid-sized, and large districts. Differences between sample schools and the state almost certainly reflect funding restrictions (Title II, Part D) and the amount of available funds per grant. The maximum grant amount ($750,000) fell well short of the amount required to support one-to-one technology in larger middle schools.

Participants

Students

Three groups or cohorts of students were included in this study, with Cohort 1 followed for four years, Cohort 2 for three years, and Cohort 3 for two years (Table 2.2). Cohort 1 (ninth graders) included a total of 5,217 students, with 2,469 treatment students enrolled at high schools and 2,748 control students enrolled at high schools; Cohort 2 (eighth graders) included 5,436 students, with 2,578 at treatment middle schools and 2,858 at control middle schools; and Cohort 3 (seventh graders) included 5,392 students, with 2,547 students at treatment middle schools and 2,845 at control middle schools.

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

Table 2.2. Student Cohorts by School Year and Grade

Year	Middle School			High School
	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**

Note. Bold text denotes the current evaluation year. In 2007-08, nearly all of Cohort 1 students attended traditional high schools. One small high school had one-to-one laptop access.

Table 2.3 shows that about 70% of ninth graders (Cohort 1), eighth graders (Cohort 2), and seventh graders (Cohort 3) are economically disadvantaged. Comparison groups have similar proportions of disadvantaged and minority students, and female and male students. The main difference between groups is the greater proportion of limited English proficient (LEP) students in treatment schools (about 7 to 12 percent more). Treatment schools also have slightly higher percentages of economically disadvantaged and Hispanic students.

Table 2.3. Demographic Characteristics of Students: 2007-08

	Enroll-ment	Eco Disadv.	Ethnicity			LEP	Gender	
			AA	Hispanic	White		Female	Male
Cohort 1 (Post-Immersion)								
Treatment								
N	2,469	1,763	146	1,803	493	442	1,198	1,271
%	47.3	71.4	5.9	73.0	20.0	17.9	48.5	51.5
Control								
N	2,748	1,914	200	1,853	678	309	1,328	1,420
%	52.7	69.7	7.3	67.4	24.7	11.2	48.3	51.7
Cohort 2								
Treatment								
N	2,578	1,946	132	1,935	485	535	1,282	1,296
%	47.4	75.5	5.1	75.1	18.8	20.8	49.7	50.3
Control								
N	2,858	2,038	232	1,948	661	346	1,388	1,470
%	52.6	71.3	8.1	68.2	23.1	12.1	48.6	51.4
Cohort 3								
Treatment								
N	2,547	1,954	110	1,934	489	670	1,234	1,313
%	47.2	76.7	4.3	75.9	19.2	26.3	48.4	51.6
Control								
N	2,845	2,050	181	1,999	651	406	1,416	1,429
%	52.8	72.1	6.4	70.3	22.9	14.3	49.8	50.2

Note. Spring 2008 student database collected from 21 treatment and 21 control schools

As Table 2.2 shows, Cohort 1 students left middle schools and enrolled as ninth graders in high schools for the 2007-08 school year. Overall, Cohort 1 treatment students attended 188 high schools, while control students attended 197 high schools. The mean percentages of economically disadvantaged students at these schools were similar for treatment and control groups (67.1% and 66.6%, respectively). Likewise, similar percentages of treatment and control students attended a high schools the same school district (89.9% for treatment students and 91.5% for control students). Specifically, 2,219 treatment students attended 58 high schools in the same school districts in 2007-08, whereas 2,515 control students attended 62 high schools in the same district. High schools attended by treatment and control students in their home districts had similar percentages of economically disadvantaged students (61.3% and 67.6%, respectively). A small number of students, however, enrolled in high schools in different school districts. There were 250 treatment students who attended 130 high schools in different districts, and 233 control students attended 135 high schools in different districts. High schools that treatment and control students attended had similar percentages of economically disadvantaged students (61.3% and 54.6%, respectively).

During the 2007-08 school year, 1,367 teachers participated in the study, including 612 at treatment campuses and 655 at control campuses (Table 2.4). Teachers in comparison groups are remarkably similar in terms of gender, ethnicity, advanced degrees, and average teaching experience. The decline in the number of teachers from the baseline to final year reflects the exclusion of two campuses.

Table 2.4. Demographic Characteristics of Teachers: Baseline and Final Year

	2004-05		2007-08	
	Treatment *N=22*	Control *N=22*	Treatment *N=21*	Control *N=21*
Number of teachers	622	682	612	655
% Female	65.4	68.8	66.3	68.4
% Minority	42.4	35.3	45.9	42.9
% African American	7.8	7.5	4.4	4.6
% Hispanic	32.2	26.3	39.3	37.0
% White	57.6	64.7	54.1	57.1
% with no degree	0.0	2.0	0.3	0.9
% with advanced degree	21.7	22.2	19.7	19.2
Average years experience	10.9	11.4	10.7	11.5

Data Collection

Data collection for the project began in August 2004 and continued through spring 2008. As Table 2.5 illustrates, researchers conducted site visits at each of the middle schools in fall 2004 and again in spring 2005 through 2008. Additional measures, administered as pre-tests in fall and post-tests in spring, included teacher online surveys and student paper-and-pencil surveys.

Table 2.5. Time Frame for Data Collection by Year

	2004-05		2005-06		2006-07		2007-08	
	Fall 2004	Spring 2005	Fall 2005	Spring 2006	Fall 2006	Spring 2007	Fall 2007	Spring 2008
Site visits (classroom observations)	X	X		X		X		X
Teacher Questionnaire (all teachers)	X	X		X		X		X
Teacher Questionnaire (new teachers)			X		X		X	
Student Questionnaire and SLI (Cohort 1)	X	X		X		X		
Student Questionnaire and SLI (Cohort 2)			X	X		X		X
Student Questionnaire and SLI (Cohort 3)					X	X		X
Texas Assessment of Academic Skills (TAKS)		X		X		X		X
Attendance		X		X		X		X
Disciplinary actions		X		X		X		X

Note. Data collection for 22 treatment and 22 control schools in 2004-05 and 21 treatment and 21 control schools in subsequent years. TAKS and attendance data were collected for spring 2003 through 2008. SLI = Style of Learning Inventory.

We also gathered school and student demographic, attendance, and achievement data from the Texas Public Education Information Management System (PEIMS) and Academic Excellence Indicator System (AEIS). Across four years, individual middle schools submitted student-level data on disciplinary actions.

Measures

Instruments measuring mediating and outcome variables included surveys and student performance measures. Survey items and scale scores reliabilities are provided in Appendix C.

Teacher Questionnaire

Immersion and control teachers completed an online technology survey in fall 2004 (September to October), and teachers new to the schools completed baseline surveys in fall 2005, 2006, and 2007. All teachers working at treatment and control schools completed follow-up surveys in spring (April to May) of 2005, 2006, 2007, and 2008. The survey included items related to school technology, teachers' technology proficiency and use, and professional development experiences. In fall 2004, 1,271 teachers completed surveys (97% of all teachers, 97% of treatment, and 98% of control). In spring 2005, 1,144 teachers (88% of all teachers, 87% of treatment, and 88% of control) completed surveys. In spring 2006, 1,175 teachers completed surveys (93% of all teachers, 92% of treatment, and 95% of control). In spring 2007, 1,208 teachers completed surveys (94% of all teachers, 94% of treatment, and 93% of control). In spring 2008, 1,159 teachers completed surveys (91% of all teachers, 87% of treatment, and 95% of control).

School mediating variables. Teachers responded to 33 items pertaining to their perceptions of school technology. They rated their strength of agreement with statements on a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Maximum likelihood factor analysis with Varimax rotation revealed five distinct factors, including Leadership (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 (Cronbach's alpha) for school-level factors ranged from 0.66 to 0.97.

Teacher mediating variables. Teacher surveys included measures of mediating variables, with items pertaining to teachers' perceptions of Technology Proficiency (27 items), Professional Productivity (17 items), Student Classroom Activities (17 items), and Collaboration (11 items related to teacher interactions with colleagues). Additionally, confirmatory factor 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) as factors. Cronbach's alpha reliability coefficients for scales ranged from 0.70 to 0.98.

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 Classroom Activities, 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

Students completed a paper-and-pencil questionnaire measuring their technology proficiency and use, and the *Style of Learning Inventory* (*SLI*), a measure of self-directed learning (i.e., self-generated behaviors oriented toward the attainment of learning goals). Cohort 2 students completed surveys as sixth graders in fall 2005 and spring 2006, as seventh graders in spring 2007, and as eighth graders in spring 2008. Cohort 3 students completed surveys as sixth graders in fall 2006 and spring 2007 and as seventh graders in spring 2008. Cohort 1 students (ninth graders) who advanced to high schools did not complete surveys in the fourth year.

Technology survey. Survey items measured students' Technology Proficiency (22 items), Classroom Activities (12 items), Technical Problems (6 items), Small-Group Work (6 items), and School Satisfaction (6 items). Cronbach's alpha coefficients ranged from 0.77 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 Classroom Activities, Technical 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*).

Technology survey response rates for students are summarized in Table 2.6. Response rates were in the 80% to 91% range from fall 2005 through spring 2008. In each time period, there were only small differences in response rates between cohorts and comparison groups.

Table 2.6. Student Technology Survey Response Rates: 2005-06, 2006-07, and 2007-08

	Fall[a]		Spring 2006		Spring 2007		Spring 2008	
	N	*%*	*N*	*%*	*N*	*%*	*N*	*%*
Cohort 2								
Treatment	2,209	84	2,379	89	2,228	84	2,110	82
Control	2,405	86	2,452	87	2,363	82	2,422	85
All	4,614	85	4,831	88	4,591	83	4,532	83
Cohort 3								
Treatment	2,233	86	--	--	2,220	85	2,130	84
Control	2,584	91	--	--	2,464	87	2,454	86
All	4,817	89	--	--	4,684	86	4,584	85

[a]Students completed surveys as sixth graders in fall 2005 and fall 2006.

Style of Learning Inventory. The *SLI* is a 48-item survey, developed by the Metiri Group (2004), that is based on a model of self-regulated learning (Schunk & Zimmerman, 1998). The items on the *SLI* are categorized into 12 scales and three groupings. The three grouping and related scales are listed below.

- *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)*. Confirmatory factor analysis of fall 2004 *SLI* data revealed low convergent validity of the scales and groupings and no discriminant validity. In addition, the scales and groupings were not internally consistent (α = 0.18 to 0.52). Because of these findings, analyses were limited to the *SLI* total score (α = 0.89).

Given consistent results across three study years showing no significant difference between treatment and control students' self-direction as measured by *SLI* total scores, we limited the administered of the *SLI* in spring 2008 to Cohort 2 students only. Table 2.7, which summarizes *SLI* response rates, shows that the rates for Cohorts 2 and 3 students have ranged from 77% to 89% across time periods. With the exception of the spring 2005 *SLI* administration, there were only small differences in response rates between cohorts or comparison groups.

Table 2.7. Style of Learning Inventory Response Rates: 2005-06, 2006-07, and 2007-08

	Fall[a]		Spring 2006		Spring 2007		Spring 2008	
	N	%	*N*	%	*N*	%	*N*	%
Cohort 2								
Treatment	2,115	80	2,198	82	2,201	83	1,989	77
Control	2,265	81	2,228	79	2,368	82	2,318	81
All	4,380	80	4,426	80	4,569	83	4,307	79
Cohort 3								
Treatment	2,173	84	--	--	2,209	85	--	--
Control	2,534	89	--	--	2,434	86	--	--
All	4,707	87	--	--	4,643	85	--	--

[a]Students completed the Style of Learning Inventory as sixth graders in fall 2005 and 2006.

Observation of Teaching and Learning

Researchers have conducted classroom observations for core-subject teachers (reading/English language arts, mathematics, science, and social studies) who instructed Cohorts 1, 2, and 3 students. In fall 2004 and spring 2005, we observed in a sample of sixth-grade classrooms. In spring 2006, we observed a sample of classrooms including sixth- and seventh-grade teachers. In spring 2007 and 2008, we observed a sample of classrooms including sixth-, seventh-, and eighth-grade teachers.

The Observation of Teaching and Learning (OTL) form documents basic descriptive information (e.g., number of students, content area), 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 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, Secada, and Wehlage (1995), observers rated four standards measuring the intellectual quality of classroom instruction on a 5-point scale: Higher Order Thinking, Disciplined Inquiry, Substantive Conversation, and Value

Beyond School. An aggregate score across three of the standards was used as an overall measure of the Intellectual Challenge of instruction. We excluded the Substantive Conversation standard because ratings were biased by teachers' classroom organization. Classes with teacher-directed instruction typically provided more public conversations, and thus, better opportunities to document the nature of conversational exchanges.

Number of observations. During fall 2004, researchers conducted observations at half of middle schools (11 treatment and 11 control). Subsequently, we expanded observations to all of the middle schools. In fall 2004, researchers observed 125 classrooms (60 treatment and 65 control); in spring 2005, we conducted follow-up observations, when possible, in the same classrooms. Altogether, we observed 206 classrooms (105 treatment and 101 control) in spring 2005. The following year (spring 2006), we observed 217 classrooms (114 treatment and 103 control). These observations included a nearly equal mix of sixth- and seventh-grade classrooms. In spring 2007 and 2008, respectively, we observed 194 classrooms (95 treatment and 99 control) and 230 classrooms (117 treatment and 113 control). These observations included a combination of sixth-, seventh-, and eighth-grade classrooms. At small campuses, researchers observed nearly all core-subject teachers. For larger campuses, we observed a representative sample of core teachers.

Training procedures. Prior to site visits in fall 2004 and spring of 2005, 2006, and 2007, researchers participated in one- or two-day training events. Training activities informed data collectors about the research design, aspects of Technology Immersion, data collection protocols, effective interview and focus group techniques, and classroom observation procedures. Approximately half of each training event was devoted to the establishment of inter-rater agreement on the 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. Individualized training was provided for new researchers in 2008.

To further enhance inter-rater agreement, raters were paired for observations in classrooms during visits to a middle school selected for training purposes. Following paired classroom observations in these schools, raters again discussed assigned ratings and resolved disagreements. Subsequently, for site visits to treatment and control middle schools, observers were paired for about 25% of classroom observations. Overlapping observations allowed the calculation of the consistency of observers' scores (i.e., the percentage of agreement on ratings from paired observations). Additionally, paired observations supported the use of Many-Facet Rasch Measurement (MFRM) to adjust scores on the Intellectual Challenge factor for differences across raters.

Inter-rater agreement. Inter-rater agreement on the rating scales for the Intellectual Challenge standards (Higher-Order Thinking, Disciplined Inquiry, Substantive Conversation, and Value Beyond School) was established by calculating the percentage of time observers agreed on ratings from paired observations. Analyses of observations from fall 2004 indicated 78% inter-rater agreement. Agreement reached 98% when scale categories were allowed to vary by one scale point (on the 5-point scale). Inter-rater agreement declined somewhat in spring 2008. Exact agreement for spring 2005 through 2008 was 63%, 62%, 62%, and 56%, respectively, and 89%, 93%, 96%, and 92%, respectively, when ratings varied by one scale point.

Reliability of scores. Statistics for inter-rater agreement indicated that raters may have had somewhat different standards for assigning scores, so we needed to adjust statistically for the differences in the severity of raters. An overall measure of Intellectual Challenge for each teacher was constructed using MFRM. The quality of instruction measure is an aggregate score across three standards (Higher Order

Thinking, Disciplined Inquiry, and Value Beyond School). The measure is adjusted for the relative difficulty of each standard and the relative severity (or leniency) of each observer. MFRM analysis 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. "Misfitting" raters have been defined as having either a mean-square infit or outfit statistic greater than 1.5 (Lunz, Wright, & Linacre, 1990), or the range has been from 0.5 to 3.0 (Myford & Wolfe, 2000). 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). Observation data in fall 2004, and spring 2005, 2006, 2007, and 2008, respectively, resulted in observer infit values from 0.61 to 1.34, 0.61 to 1.34, 0.43 to 1.59, 0.58 to 1.14, and 0.62 to 1.59. Observer outfit values over the five time periods ranged from 0.62 to 1.20, 0.62 to 1.20, 0.40 to 1.67, 0.66 to 1.17, and 0.65 to 1.48. While the spring 2006 and spring 2008 fit statistics extended slightly beyond the 0.5 to 1.5 range, mean infit and outfit values were in the 0.90 to 1.00 range. No unusual rating patterns appeared to be present in the spring 2006 and spring 2008 classroom observation data, with only slightly unpredicted or overly predictable ratings (Linacre, 1995).

Texas Assessment of Knowledge and Skills (TAKS)

The TAKS is Texas' criterion-referenced assessment that annually measures students' mastery of the state's content standards. TAKS assesses reading at grades 3 to 9; English language arts at grades 10 and 11; writing at grades 4 and 7; mathematics at grades 3 to 11; science at grades 5, 8, 10, and 11; and social studies at grades 8, 10, and 11. Stringent quality control measures are applied at all stages of test administration, scanning, scoring, and reporting. Internal consistency reliabilities for TAKS assessments are in the high .80s to low .90s range. Evidence also supports the content, construct, and criterion-related validity of TAKS assessments.[2]

Table 2.8 shows the TAKS completion schedule for Cohorts 1, 2, and 3 students. Students complete TAKS reading and mathematics assessments annually, so all student cohorts have pretest and posttest measures. For the present study, Cohort 2 students completed TAKS science in 2005 (5th grade) and 2008 (8th grade), and TAKS social studies in 2008. Cohort 3 students completed the TAKS writing assessment in 2005 (4th grade) and 2008 (7th grade).

Table 2.8. Texas Assessment of Knowledge and Skills Completion Schedule by Student Cohort

	Texas Assessment of Knowledge and Skills (TAKS)														
	Reading			Mathematics			Writing			Social Studies			Science		
Year	C1	C2	C3	C1	C2	C3	C1	C2	C3	C1	C2	C3	C1	C2	C3
2003	*X*	-	-	*X*	-	-	*X*	-	-	-	-	-	-	-	-
2004	X	*X*	-	X	*X*	-	-	*X*	-	-	-	-	*X*	-	-
2005	X	X	*X*	X	X	*X*	-	-	*X*	-	-	-	-	*X*	-
2006	X	X	X	X	X	X	X	-	-	-	-	-	-	-	-
2007	X	X	X	X	X	X	-	X	-	X	-	-	X	-	-
2008	X	X	X	X	X	X	-	-	X	-	X	-	-	X	-

Note. C1 = Cohort 1, C2 = Cohort 2, and C3 = Cohort 3. *Italic* text means the TAKS score was used as a pre-test measure.

[2] Technical information is available on the Texas Education Agency website at http://www.tea.state.tx.us/student assessment/resources/techdig04/index.html.

At grades 6, 7, and 8, TAKS reading measures four objectives: understanding of culturally diverse written texts, knowledge of literary elements, use of strategies to analyze written texts, and application of critical-thinking skills. At grade 9, TAKS reading measures three objectives: understanding of culturally diverse written texts, understanding of the effects of literary elements and techniques in diverse texts, and the ability to analyze and critically evaluate diverse texts and visual representations. In addition to multiple-choice items, ninth graders respond to several open-ended (short-answer) items.

TAKS mathematics at grades 6, 7, and 8 measures six objectives: numbers, operations, and quantitative reasoning; patterns, relationships, and algebraic reasoning; geometry and spatial reasoning; concepts and uses of measurement; probability and statistics; and mathematical processes and tools used in problem solving. TAKS mathematics at grade 9 measures 10 objectives: functional relationships; properties and attributes of functions; linear functions; formulation and use of linear equations and inequalities; quadratic and other nonlinear functions; geometric relationships and spatial reasoning; two- and three-dimensional shapes; concepts and uses of measurement and similarity; percents, proportional relationships, probability, and statistics; and underlying processes and mathematical tools. Each ninth grader must have a graphing calculator for use during the test. All TAKS mathematics tests include a combination of multiple-choice and open-ended griddable response items.

At grade 7, TAKS writing measures six objectives: given a context, produce an effective composition for a specific purpose; demonstrate a command of conventions of spelling, capitalization, punctuation, grammar, usage, and sentence structure; recognize appropriate organization of ideas in written text; recognize correct and effective sentence construction in written text; recognize standard usage and appropriate word choice in written text; proofread for correct punctuation, capitalization, and spelling in a written text. At grade 8, TAKS science measures five objectives: nature of science; living systems and the environment; structures and properties of matter; motion, forces, and energy, and earth and space systems. Grade 8 TAKS social studies measures five objectives: history, geography, economics and social influences, political influences, and social studies skills.

School Attendance and Disciplinary Actions

Post-measures of student attendance for Cohort 1 came from PEIMS data for the 2004-05, 2005-06, 2006-07, and 2007-08 school years; attendance data from 2003-04 served as the pre-measure. Similarly, for Cohort 2, student attendance data for 2005-06, 2006-07, and 2007-08 provided post-measures while data from 2004-05 served as the pre-measure. Likewise, for Cohort 3, student attendance data for 2006-07 and 2007-08 provided post-measures and data from 2005-06 served as the pre-measure. Additionally, individual campuses submitted data for student disciplinary actions taken during the 2007-08 school year. Data files included an indicator for the total number of Disciplinary Action Reports (PEIMS 425 records) reported for each student (Cohorts 2 and 3) during the school year.

3. Technology Immersion—Fourth-Year Implementation

Researchers have investigated the implementation of Technology Immersion across four project years. Second- and third-year findings showed that many of the 21 treatment schools had difficulty implementing the prescribed components of the Technology Immersion model. Still, implementation varied by campus and some schools reached implementation levels that more nearly met substantial to full immersion standards. Given that implementation quality has been associated with desirable project outcomes (e.g., Berman & McLaughlin, 1978; Borman, 2005; Borman, Hewes, Overman, & Brown, 2003; Datnow, Borman, & Stringfield, 2000), we continued to monitor schools' progress in the fourth year. This chapter begins with a description of Technology Immersion and the use of Technology Immersion packages as a means to operationally define the treatment and ensure more consistent implementation across sites. Next, we describe our approach to measuring implementation. Finally, findings are presented on the fidelity of fourth year implementation at the treatment schools, and comparisons are made between the second (2005-06), third (2006-07), and fourth (2007-08) project years.

Defining Technology Immersion

As a way to promote consistent interpretation of the Technology Immersion model and comparability of implementation across schools, the Texas Education Agency (TEA) issued a Request for Qualifications (RFQ) that allowed commercial vendors to apply to become providers of Technology Immersion packages (TEA, 2003). State statute provided a general description of Technology Immersion, but the concept and its component parts were defined operationally to foster uniformity. Vendors had to include 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 learning tools;
- 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 an expert review 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]). Package costs, which ranged from about $1,100 to $1,600 per student, varied according to the numbers of students and teachers, the type of laptop computer, and the vendor provider. Of the 21 immersion sites studied in the second through fourth years, 5 middle schools selected the Apple package, 15 selected the Dell package, and 1 school selected the Region 1 ESC package (Dell computer). Table 3.1 provides an overview of the basic components within each package and the individual vendors that provided various products. All vendors offered a wireless laptop as the mobile computing device (Apple or Dell), and all laptops had a suite of productivity tools (either *AppleWorks* or *Microsoft Office*). Dell computers also had a web-based portal (*eChalk*) to applications and resources.

Table 3.1. Technology Immersion Packages

Component	Apple *N* = 5 Schools	Dell *N* = 15 Schools	Region 1 ESC *N* = 1 School
Wireless laptop computer	Apple iBook G4	Dell Inspiron or Latitude	Dell Inspiron
Productivity software	AppleWorks	MS Office eChalk	MS Office eChalk
Online resources	Various	Various	Various
Online assessment	*AssessmentMaster*	*i-Know*	*i-Know*
Professional development	Apple Model	Pearson Achievement, *Dell Exchange*	ESC 1, Classroom Connect
Technical and pedagogical support	Apple, Campus/District	Dell, Campus/District	ESC 1, Campus/District

Immersion packages also included a variety of digital resources. Apple provided *netTrekker*, *ClassTools Math, ExploreLearning Math and Science, TeenBiz3000*, and *My Access Writing*. Dell provided *netTrekker* and *Connected Tech*, and Region 1 ESC provided *Connected Tech*, *Unitedstreaming, Encyclopedia Britannica, EBSCO, NewsBank*, and *K12 Teaching and Learning Center*. Packages also included formative assessments (*AssessmentMaster* or *i-Know)*. Additionally, each vendor provided professional development as well as ongoing technical support. Apple had its own professional development model. Dell relied on a commercial provider (*Pearson Learning Group)* and the *Dell Exchange* (an online resource). Region 1 ESC used a combination of service center support plus services offered through *Connected Coaching* and *Connected University*. (See Appendix D for a more comprehensive description of the package components.)

During the third and fourth implementation years, schools began to selectively purchase online resources and assessments according to their perceived needs. For example, some schools dropped the online assessments because they had state-provided or local assessments that filled their testing needs. Two schools (with Dell and ESC 1packages) purchased the *My Access Writing* program included in the Apple package. Schools and teachers also continued to supplement package resources with products purchased locally, provided through state textbook adoptions, or obtained from the Internet free of charge.

Measuring Implementation Fidelity

Implementation is measured as the fidelity with which Technology Immersion *components* and related *elements* attain an envisioned "ideal." This approach involved gathering extensive data on immersion components at each of the treatment campuses and comparing campus-to-campus variations with the vision for "full" implementation. The seven immersion components include five supports for implementation (Leadership, Teacher Support, Parent and Community Support, Technical Support, and Professional Development) and two components related to teacher and student implementation outcomes (Classroom Immersion and Student Access and Use). Consistent with previous years, we used a two-part measurement approach in the fourth year. First, we used indicators to describe each school's progress on a 4-stage scale toward immersion standards. Rating scales for components and related elements identified four levels of immersion: *minimal* (0 to 1.99), *partial* (2.00 to 2.99), *substantial* (3.00 to 3.49), and *full* (3.50 to 4.00). Second, we used quantitative implementation indices to gauge the level of Technology Immersion using standardized scores (z scores). Z scores allowed the calculation of composite scores across indicators with varying scales and standard deviations.

Implementation Indicators

Both the immersion standard scores and implementation indices were derived from values for the seven components and their related elements. Fourth-year scores came from spring 2008 surveys of teachers (*N* = 534, including 337 core-subject teachers) and students (*N* = 6,327) at treatment schools. Table 3.2 provides descriptions of the Technology Immersion indicators. Appendix D provides additional technical detail on the measurement of implementation fidelity and the scoring rubrics that described the four levels of immersion.

Table 3.2. Description of Implementation Indicators for Technology Immersion

Support for Technology Immersion
Leadership
To what extent do teachers indicate that administrators establish a clear vision and expectations, encourage integration, provide supports, and involve staff in making decisions about instructional technology.
Teacher Support
To what extent do teachers share an understanding about technology use, do teachers continually learn and seek new ideas, are teachers unafraid to learn about and use technologies, and are teachers supportive of integration efforts.
Parent and Community Support
To what extent do teachers believe that parents and the surrounding community support the school's efforts with technology.
Technical Support
To what extent do teachers indicate that technical problems with computers, Internet access, repairs, and material availability pose barriers to Technology Immersion.
Professional Development
Contact Hours: To what extent does the duration (hours) of technology-related professional development (PD) support the integration of technology into teaching, learning, and the curriculum.
Classroom Support: To what extent do core-subject teachers receive coaching or mentoring from an internal source, such as another teacher or technology coordinator, or an external (non-school) source.
Content Focus: To what extent do core-subject teachers indicate that PD emphasizes curriculum, instructional methods, and lesson development in core subjects.
Coherence: To what extent do core-subject teachers indicate that PD is consistent with personal and school goals, builds on prior learning, and supports state standards and assessments.
Classroom Immersion
Technology Integration: To what extent do core teachers alter instructional practices, allocate time, integrate research on teaching and learning, improve basic skills, and support higher order thinking through technology.
Learner-Centered Instruction: To what extent do teachers have students establish learning goals, use information and inquiry skills, complete alternative assessments, and have active and relevant learning experiences.
Student Classroom Activities: To what extent do teachers have students use particular technology resources for learning in core-subject classes, such as a word processor for writing, a spreadsheet for calculation or graphing, or the Internet for research.
Communication: To what extent do teachers use technology to communicate with students, parents, and colleagues or to post information on a class website.
Professional Productivity: To what extent do teachers use technology to enhance their professional productivity (e.g., keep records, analyze data, develop lessons, deliver information).
Student Access and Use
Laptop Access: To what extent do students have access to wireless laptops throughout the school year.
Core-Subject Learning: How frequently do students use technology resources for learning in core-subject classes.
Home Learning: To what extent do students have access to and use laptops outside of the school for homework and learning.

Note. See Appendix D for a technical description of the measurement of implementation indicators.

Computing Implementation Scores

Scores for Immersion Standards

We used teacher and student survey data to compute implementation scores for indicators that measured progress toward immersion standards (i.e., minimal to full implementation). Adapting a process developed by the RAND Corporation,[1] the value for each indicator was computed relative to the maximum value (4.00—the value assigned to full implementation). Standardization based on the maximum value allowed comparisons across different types of indicators. For each component and element of Technology Immersion, standardization involved the following computations:

- **Agreement scales** (i.e., strongly agree or strongly disagree with a prescribed practice or behavior): 4 = strongly agree, 3 = agree, 2 = neither agree nor disagree, 1 = disagree, and 0 = strongly disagree.
- **Frequency scales** (i.e., four- or five-level frequencies of doing a prescribed practice): 4 = highest frequency met, 3 or 2.67 = second highest frequency, 2 or 1.33 = third-highest frequency, 1 = fourth-highest frequency, and 0 = never or do not do.
- **Continuous variables** (i.e., how much time or how often a prescribed practice is done): 4 = meet or exceed requirements, and 0-3.99 = proportional fraction of requirement.

Scores for Implementation Indices

In addition to the standards-based scoring system described above, we used teacher and student survey data to compute standardized implementation indicators (*z* scores with a mean of 0 and standard deviation of 1.0) that could then be aggregated to generate:

- A single implementation score for each Technology Immersion component for each school (e.g., Leadership Index),
- a mean implementation support score for the five support components (Support Index), including Leadership, Teacher Support, Parent and Community Support, Technical Support, and Professional Development, and
- an overall mean implementation score for each school (Implementation Index), which is an average of the Support Index, Classroom Immersion Index, and Student Access and Use Index.[2]

Implementation of Technology Immersion

The sections to follow present findings on (a) the extent to which schools provided the implementation supports considered essential to advance Technology Immersion, and (b) the degree to which schools implemented components relevant to teachers' classroom immersion practices and students' technology access and use. We first present results for implementation standards (measured at four levels) that describe the extent to which the model's support components and instructional and learning components were implemented as designed. These scores showed whether middle schools attained the standards that represented what a substantially or fully immersed campus should achieve. Next, we use implementation

[1] Vernez, G., Karam, R., Mariano, L.T., & DeMartini, C. (2006). *Evaluating Comprehensive School Reform Models at Scale: Focus on Implementation.* Santa Monica, CA: RAND.
[2] Variables were standardized as z scores from their original scale or continuous variable values. The use of *z scores* rather than the *immersion standard scores* was necessary in order to aggregate data across variables that had widely varying standard deviations.

indices (z scores) to provide an overall measure of Technology Immersion (Implementation Index) and to compare the relative level of implementation for components across schools.

Implementation Standards

As explained previously, progress toward Technology Immersion standards was measured at four levels (*minimal*, 0-1.99; *partial*, 2.00-2.99; *substantial*, 3.00-3.49; *and full immersion*, 3.50-4.00) across seven components. Five components assessed the strength of supports for Technology Immersion (Leadership, Teacher Support, Parent/Community Support, Technical Support, Professional Development), whereas one component gauged the extent of teachers' Classroom Immersion and another component measured Student Access and Use (of technology). Figure 3.1 displays the mean implementation scores by component and project year.

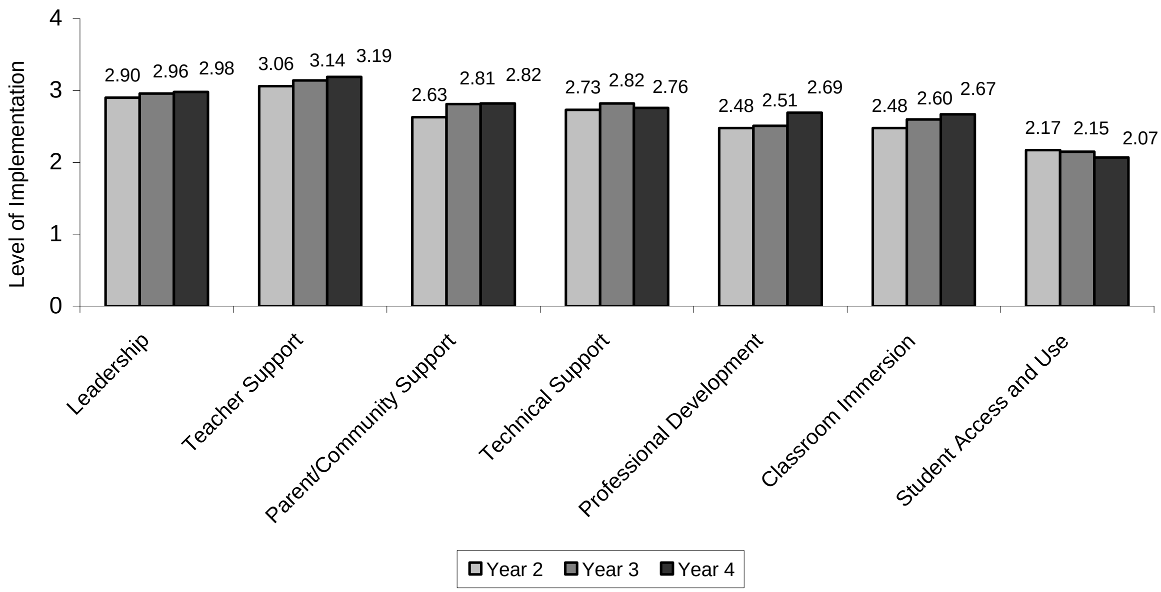


Figure 3.1. Mean level of implementation (measured on a 0 to 4 scale) for seven Technology Immersion components (N=21 middle schools) by year.[3]

Mean standard scores for Technology Immersion components generally showed small increases across years, with the exception of Technical Support (which remained fairly stable: 2.73, 2.82, and 2.76) and Student Access and Use (which declined each year: 2.17, 2.15, and 2.07). Fourth-year mean implementation support scores ranging from 2.69 (Professional Development) to 3.19 (Teacher Support) showed that supports for immersion from school administrators, teachers, the community, technical staff, and professional development providers did not reach *full* implementation standards (mean score of 3.50 to 4.00). Consistent with the second and third years, teachers, on average, reported only *partial* levels of Classroom Immersion in the fourth year (M = 2.67), and students, as a whole, reported *partial* levels of technology access and use (M = 2.07). Results for individual components, which are discussed in detail below, showed that the level of implementation varied considerably across schools.

[3] Standards-based scores for Professional Development, Classroom Immersion, and Student Access and Use are averages across elements of these components. These scores serve descriptive purposes. Composite *z* scores are used in statistical analyses.

Level of Principal, Teacher, and Parent/Community Support

The Technology Immersion model calls for the systemic integration of technology into all aspects of the school. Momentum for implementation, thus, depends upon the backing and support of individuals, establishment of institutional norms, and assistance from the surrounding community. Sections to follow describe teachers' reported support from key constituents.

Leadership. Administrators play key roles in setting the direction for Technology Immersion, providing resources, and building the capacity of staff. Thus, teachers at each school have been asked every year to rate the quality of administrative leadership. Administrators demonstrated leadership through behaviors such as involving staff in decisions, setting clear expectations for technology use, encouraging and participating in professional development events, and providing resources and support. Results in Figure 3.2 show that administrative leadership was relatively stable across three implementation years. Teachers at about half of campuses reported substantial levels of leadership. Mean scores across years (3.19, 3.25, and 3.17, respectively) indicated that these teachers either *agreed* or *strongly agreed* that administrators provided technology-related leadership. Teachers in an additional half of schools reported partial levels of administrative support (*M* = 2.64, 2.69, and 2.77, respectively).

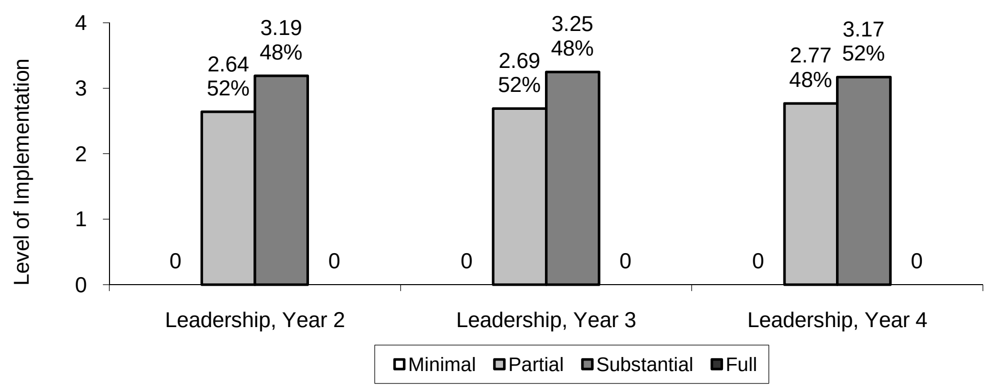


Figure 3.2. Level of implementation (measured on a 0 to 4 scale) for Leadership, by the *mean implementation score*, *percentage of schools* at each implementation level, and year.

Teacher Support. Teacher "buy-in" for Technology Immersion is critically important because students' school experiences with technology are largely dictated by their teachers. Thus, it is noteworthy that teachers reported increased levels of support for technology innovation across years (Figure 3.3). In the fourth year, teachers at two campuses (10%) reported a full level of support (*M* = 3.78). That is, teachers at these schools *strongly agreed* that they shared an understanding about technology use for student learning, were continually learning and seeking new ideas, were not afraid to learn about and use new technologies, and were supportive of integration efforts. Teachers at two-thirds of schools reported a substantial level of support for technology innovation (*M* = 3.22). In contrast, teachers at a quarter of campuses reported just partial levels of support (*M* = 2.86).

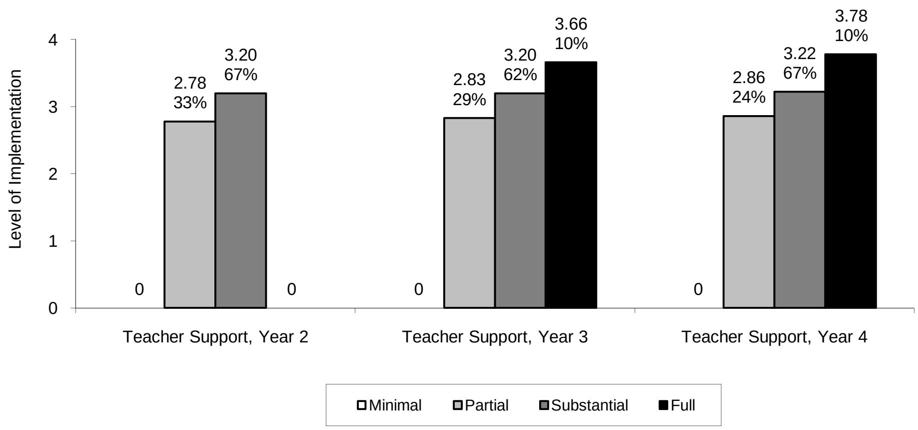


Figure 3.3. Level of implementation (measured on a 0 to 4 scale) for Teacher Support, by the *mean implementation score*, *percentage of schools* at each implementation level, and year.

Parent and Community Support. Since parents must share responsibility for an expensive laptop computer with their child or children, their understanding of and support for Technology Immersion is imperative. Additionally, the enthusiastic support of community members, including elected members of the local school board and business people, may influence implementation through mechanisms such as the adoption of supportive policies, provision of resources, or promotion of positive public relations. Given the importance of parent and community support, teachers' perceptions of such support are important (Figure 3.4). In the fourth year, teachers at less than a third of schools reported substantial to full levels of parent and community support (*M* = 3.16 and 3.63, respectively), with teachers generally agreeing that parents and the surrounding community supported their efforts with technology. Conversely, teachers at nearly three-quarters of schools reported just partial levels of parent and community support (*M* = 2.65). Fourth-year results represented a reduction in parent/community support compared to the third year when teachers at more than a third of schools reported substantial levels of support and less than two-thirds of schools had partial support. Thus, garnering parent and community support was a greater problem at some schools in the fourth year.

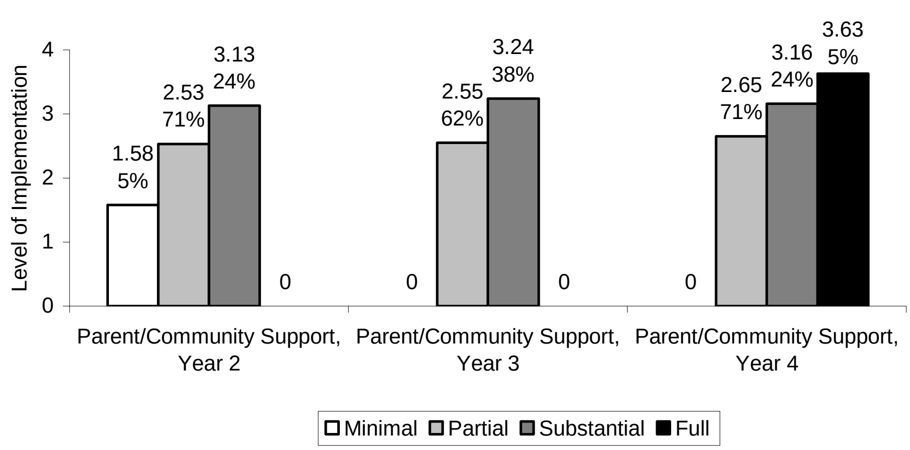


Figure 3.4. Level of implementation (measured on a 0 to 4 scale) for Parent and Community Support, by the *mean implementation score*, *percentage of schools* at each implementation level, and year.

Level of Technical and Pedagogical Support

Technical and pedagogical supports are critical aspects of the Technology Immersion model. As schools build their network infrastructure and acquire computer hardware and technology resources, ongoing technical support for all components of immersion and ongoing professional development in integrating technology into teaching and learning are essential for successful implementation.

Technical Support. Technical support for immersion should be provided by vendor technicians as well as district and campus staff who assist with implementation and offer timely support when technical problems arise. Results in Figure 3.5 show that the level of technical support improved at some schools over time. Teachers at about a third of schools reported substantial or full levels of technical support in the fourth year (*M* = 3.10 and 3.50, respectively). Although teachers at two-thirds of schools reported just partial levels of technical support (*M* = 2.56), this was fewer schools than in the previous two years. Teachers at schools with partial implementation were generally *unsure* that school computers were kept in working order, requests for assistance were addressed in a timely way, Internet connections worked adequately, and classroom materials were readily available. Despite improvements, technical problems continued to challenge teachers at many schools in the fourth year.

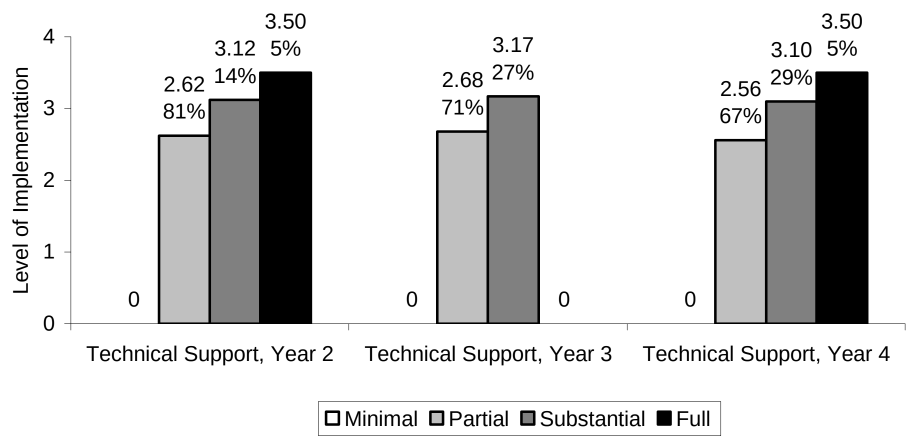


Figure 3.5. Level of implementation (measured on a 0 to 4 scale) for Technical Support, by the *mean implementation score*, *percentage of schools* at each implementation level, and year.

Professional Development. Each of the Technology Immersion packages included a professional development component designed to support all educators on an implementing campus. The immersion model required professional development that instructed teachers in effective classroom integration and was delivered through proven methods (i.e., learning through a variety of delivery systems, collaboration, sustained learning opportunities, and ongoing coaching and support). In addition to professional development provided by immersion package vendors, each school was offered a grant in the fourth year to participate in the Intel Teach Program. Grant funds paid expenses to train Intel Master Teachers (MTs) and provided stipends for at least 10 participant teachers to be trained by the MT. Master Teachers participating in the train-the-trainer model selected one of two Intel Teach professional development options: Essential Skills Course (development of a curricular unit integrating technology) and Teaching Thinking with Technology Course (use of technology tools to advance students' higher order thinking skills). Of the 21 treatment schools, 17 schools received grants to train at least one MT who provided school-based training for their peers.

Although professional development should support all teachers at a school, our implementation measure concentrated on core-subject teachers because of their close association with measured student academic outcomes. Year-to-year comparisons displayed in Figure 3.6 for the composite Professional Development indicator (mean score for four standards-based elements) show there was little difference in the levels of implementation between the second and third project years, but the quality of professional development improved at several schools in the fourth year. Although about two-thirds of campuses had minimal to partial levels of implementation for professional development in the fourth year (*M* = 1.81 and 2.50, respectively), the remaining campuses achieved substantial or full levels of professional development (*M* = 3.13 and 3.54, respectively).

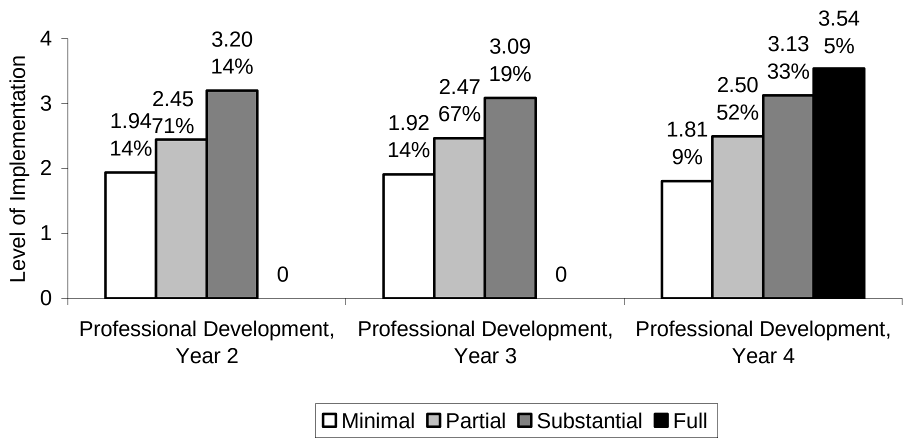


Figure 3.6. Level of implementation (measured on a 0 to 4 scale) for Professional Development, by the *mean implementation score*, *percentage of schools* at each implementation level, and year

Figure 3.7 compares the implementation levels for each of the elements that contributed to the composite Professional Development measures. Mean immersion standard scores increased in the fourth year across all of the professional development indicators, with the greatest improvement for Contact Hours and Content Focus.

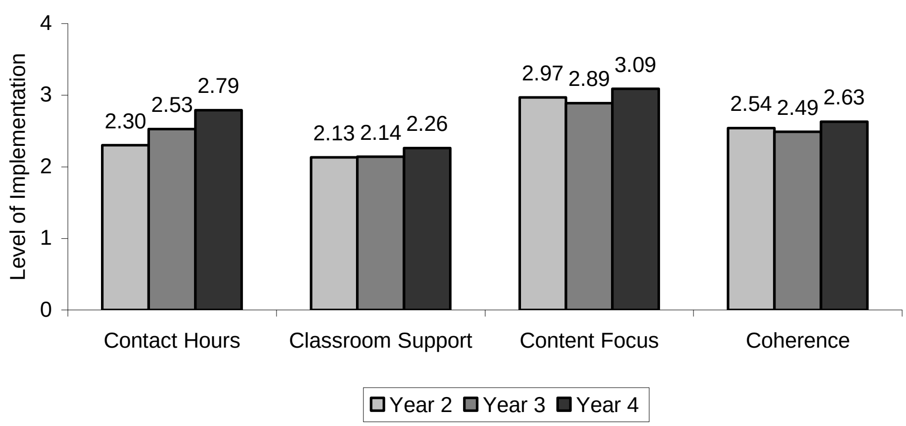


Figure 3.7. Level of Implementation (measured on a 0 to 4 scale) for elements of the Professional Development component by *mean implementation score* and year.

Despite annual increases in Contact Hours, core teachers reported receiving less than the prescribed number of hours of technology-related professional development in the fourth year (estimated to be about 50 or more hours per year). The mean implementation score (2.79) indicated that teachers, on average, participated in 37 hours or less of technology-related professional development. Additionally, similar to previous years, teachers reported that they received just partial levels of classroom support for

Technology Immersion (*M* = 2.26), indicating that teachers as a whole *rarely* (a few times a year) or *never* received classroom coaching or mentoring from an internal source (such as another teacher or technology coordinator) or external source (such as a vendor-provided professional trainer).

Moreover, teachers as a whole often failed to see the coherence of technology-related professional development with their personal goals, earlier learning experiences, and state/district curriculum standards and assessments. Like previous years, teachers' mean rating in the fourth year (2.63) indicated that professional development was coherent *to a minimal extent* (partial implementation). Core-subject teachers, however, expressed stronger beliefs in the fourth year about the extent to which professional development activities supported their curricular and instructional goals. Teachers mean score of 3.09 (substantial implementation) indicated that the content of professional development placed a *minor* to *major* emphasis on curriculum, instructional methods, and lesson development in core areas.

Level of Classroom Immersion

Given the needed equipment, digital resources, and support for Technology Immersion, teachers are expected to design technology-enhanced learning environments and integrate technology into teaching, learning, and the curriculum. Cross-year comparisons for teachers' composite level of Classroom Immersion show that teachers at several schools made progress in creating technology-immersed classrooms (Figure 3.8). Teachers at about a fifth of schools had substantial levels of classroom immersion in the fourth year (*M* =3.11), which was twice as many schools compared to the previous year. Nevertheless, teachers at a majority of schools reported only partial levels of Classroom Immersion each year, although mean scores for partial implementers increased across years (2.45, 2.47, and 2.60, respectively). Each year, one school (5%) had a minimal level of Classroom Immersion.

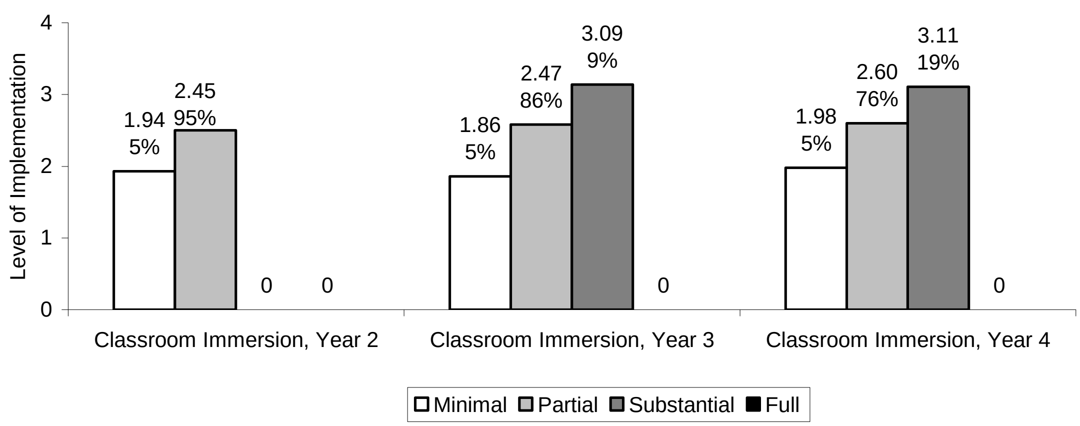


Figure 3.8. Level of implementation (measured on a 0 to 4 scale) for the Classroom Immersion, by the *mean implementation score*, *percentage of schools* at each implementation level, and year.

Figure 3.9 illustrates teachers' level of implementation relative to five elements of Classroom Immersion: Technology Integration, Learner-Centered Instruction, Student Classroom Activities (with technology), Communication, and Professional Productivity. On average, teachers reported partial levels of implementation across years for four of the five elements of Classroom Immersion. Teachers' use of technology for their own Professional Productivity reached a substantial level of implementation in the fourth year (*M* = 3.04). For most of the elements, except Technology Integration, teachers reported slightly stronger implementation in the fourth year, with the largest increase for teachers' use of technology to enhance their Professional Productivity. Comparisons across years indicate that teachers, on average, became somewhat more positive about technology integration, learner-centered instructional methods, the use of technology as a communication tool, and technology use for professional productivity. In contrast, the frequency with which core-subject teachers had *students* in their classrooms use technology for learning activities remained relatively stable across years. In general, teachers at many schools seemed to view technology as a more valuable tool for themselves than for their students.

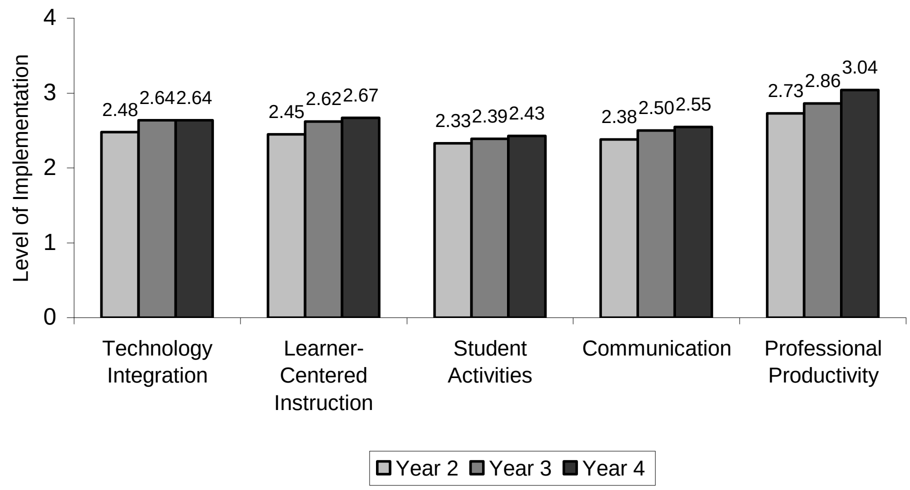


Figure 3.9. Level of Implementation (measured on a 0 to 4 scale) for five elements of Classroom Immersion by *mean implementation score* and year.

Level of Student Technology Access and Use

The transformation of classroom experiences is a vital part of Technology Immersion, but the model also aims for students to have on-demand technology access both within and outside of school that allows them to become more independent and self-determined learners. Overall, data reported by students indicated that Student Access and Use remained relatively stable across the second and third project years but declined substantially at several schools in the fourth year (Figure 3.10).

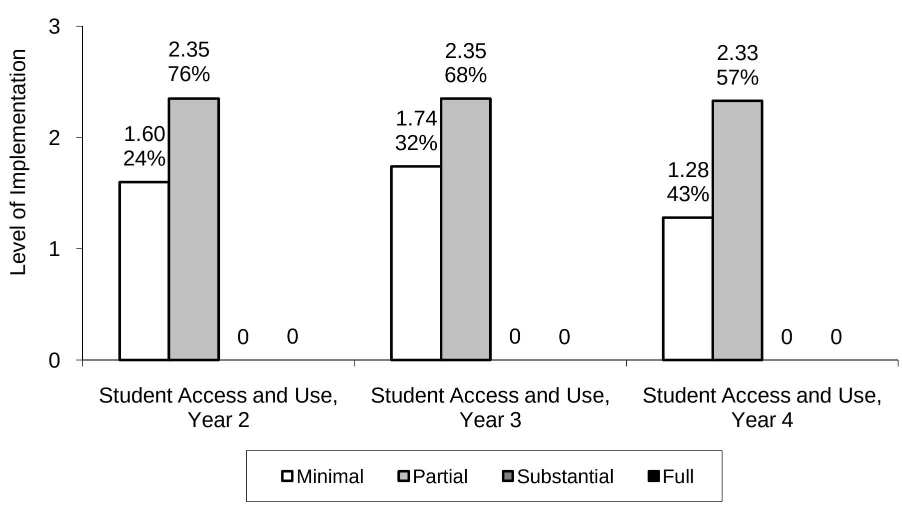


Figure 3.10. Level of implementation (measured on a 0 to 4 scale) for the Student Access and Use, by the *mean implementation score*, *percentage of schools* at each implementation level, and year.

The percentage of schools with partial levels of Student Access and Use decreased across years (from 76% to 57%), whereas the percentage of schools with minimal access and use increased (from 24% to 43%). Moreover, the mean implementation level at schools with minimal access and use declined to the lowest level in the fourth year (1.28 compared to 1.60 and 1.74 in the previous two years). In contrast, the mean level of implementation at schools with partial Student Access and Use remained fairly stable across project years (2.35, 2.35, and 2.33, respectively).

Figure 3.11 shows the average level of implementation for three elements of Student Access and Use: Laptop Access Days, Core-Content Learning, and Home Learning. First, in a fully immersed school, all students should have access to their wireless laptops and resources nearly the entire school year (about 170 to 180 days). Schools as a whole, however, had difficulty keeping laptops in the hands of students. Year-to-year comparisons indicated that the mean implementation level for Laptop Access Days declined between the second and third years (from 2.69 to 2.50) but improved in the fourth year (2.64). Thus, students, on average, had laptops available for a larger number of days in the fourth year. Even so, partial levels of implementation indicated that students' access to laptops varied at schools to a *large extent* (from 100 to 176 days per student). In the fourth year, students at 33% of schools reported either substantial or full laptop access. In contrast, students at 57% of schools reported partial access, and students at 10% of schools reported minimal laptop access.

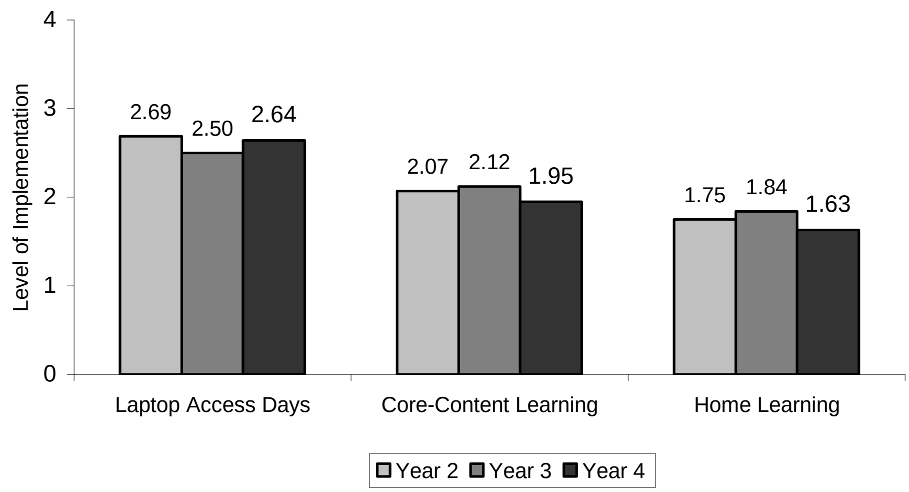


Figure 3.11. Level of Implementation (measured on a 0 to 4 scale) for three elements of Student Access and Use by *mean implementation score* and year.

Students also estimated how often they used laptops in their English/language arts, mathematics, science, and social studies classes and for learning at home. In contrast to improvement in Laptop Access Days, there were notable decreases in the fourth year for both Core-Content Learning and Home Learning. Students as a whole reported a minimal level of implementation in the fourth year for Core-Content Learning (M = 1.95), suggesting that they *rarely* (a few times a year) or *never* used laptops in core-subject classrooms. Students, on average, used their laptops even less frequently for learning outside of school in the fourth year. Students reported a minimal level of laptop use for home learning each year, and the mean level of laptop use for schoolwork outside of school declined substantially in the fourth year (1.75, 1.84, and 1.63). Thus students, on average, used their laptops outside of school for homework and learning either *not at all* or *to a trivial extent*.

Overall, students' opportunities to use their laptops both within classrooms and outside of school were affected by the number of days that students actually had their laptops. In some schools, students' laptop access days were drastically reduced by factors such as time for repairs, technical issues, disciplinary infractions, and parent resistance. Students in other schools, contrary to the tenets of Technology Immersion, were not allowed to take their laptops home, or their home use was restricted in some way (e.g., laptops could only be used for special assignments). A few treatment schools in the fourth year took individual laptops from students and placed them on laptop carts, distributed them as classroom sets, or put them in computer labs. Although laptops in such configurations may be available for student use, fourth-year findings indicate that deviation from the one-to-one student laptop access model is associated with reduced use of laptops for learning in core classes and at home.

In sum, overall results for the implementation of Technology Immersion as measured by standards-based scores show that the levels of support for implementation increased to some extent between the second and fourth project years. Similarly, teachers' reported a slightly increased level of Classroom Immersion, although it largely reflected their growing use of technology for their own productivity. In contrast, the level of Student Access and Use declined in the fourth year. Findings for standards-based scores also showed that the level of implementation varied by campus. By the end of the fourth year, none of the middle schools achieved *full immersion*, and evidence suggested that just a few campuses reached *substantial immersion*, and a majority of schools achieved *minimal* to *partial immersion*.

Implementation Indices

To further illustrate each school's level of immersion in the fourth year, Table 3.3 presents the composite campus Implementation Index (*z* score) alongside implementation indices (*z* scores) for each of the seven components. Z scores have a mean of 0 and a standard deviation of 1.0. Thus, the campus score indicates how many standard deviations from the mean a score lies. Schools with scores above 0 have higher values on the components of Technology Immersion, whereas schools with index values below 0 show less evidence of immersion. The Implementation Index is an average score for the Support Index, Classroom Immersion Index, and Student Access and Use Index.

Table 3.3. Fourth-Year Implementation of Technology Immersion

Middle School (MS)	Support Index					Classroom Immersion Index	Student Access/Use Index	**Implementation Index**
	Leadership Index	Teacher Support Index	Parent/ Comm. Index	Technical Support Index	PD Index			
MS 1	1.69	2.19	2.25	2.05	0.88	1.23	2.02	**2.58**
MS 2	1.00	0.36	0.15	0.48	0.54	1.52	1.77	**1.78**
MS 3	1.30	0.54	1.60	1.11	-0.28	0.75	0.49	**1.08**
MS 4	0.45	2.27	0.73	-0.16	2.08	1.71	-0.99	**0.99**
MS 5	0.42	0.50	0.38	-0.83	0.75	0.10	0.47	**0.40**
MS 6	0.01	0.36	-1.06	0.19	0.52	-0.13	0.97	**0.39**
MS 7	0.49	-0.56	-0.09	0.98	0.41	-0.05	0.25	**0.25**
MS 8	0.50	0.13	0.70	0.72	0.01	-0.45	0.20	**0.15**
MS 9	-0.19	0.35	-0.11	-0.74	0.94	-0.19	0.39	**0.12**
MS 10	-0.53	0.03	-0.57	-1.48	0.80	0.45	-0.33	**-0.17**
MS 11	-0.83	0.94	-1.58	-1.67	-1.30	1.57	-0.81	**-0.22**
MS 12	0.81	-0.23	-0.88	-0.17	-0.71	0.25	-0.42	**-0.23**
MS 13	-0.02	-0.81	0.85	0.95	-0.02	0.66	-1.50	**-0.25**
MS 14	0.39	-0.23	0.43	-0.02	0.09	-0.35	-0.41	**-0.25**
MS 15	-1.29	-0.23	0.39	1.08	0.96	-1.31	0.20	**-0.38**
MS 16	0.85	-0.10	-0.50	-0.13	-1.77	-0.77	0.14	**-0.49**
MS 17	-1.61	-1.58	-0.12	-0.12	-1.05	-1.21	0.79	**-0.72**
MS 18	-2.33	-0.28	0.81	0.79	-2.05	-2.07	0.73	**-0.98**
MS 19	-0.51	-1.38	-1.34	-1.08	-0.20	-0.44	-1.08	**-1.24**
MS 20	-0.98	-1.19	-0.96	-1.61	0.04	-0.45	-1.21	**-1.33**
MS 21	0.36	-1.10	-1.32	-0.34	-0.61	-0.82	-1.69	**-1.49**

Note. Implementation indices are *z* scores with a mean of 0 and a standard deviation of 1.0. Scores above zero indicate a greater presence of Technology Immersion components and higher levels of implementation.

Despite some variations in component scores, middle schools with positive values on the Implementation Index tended to have component scores that indicated a stronger presence of the immersion attributes such as administrative leadership and teacher support for immersion. In contrast, middle schools that had the most negative values on the Implementation Index generally had negative values for nearly all of the immersion components. These findings suggest that the implementation indices are relatively effective in discriminating higher and lower implementing schools. Still, there are exceptions to the prevailing trends. Some schools, such as MS 3, had generally higher implementation values for most of the indicators except Professional Development (-0.28). This suggests that professional development for teachers was a lower priority at this school in the fourth year. MS 4 had generally high levels of school support and Classroom Immersion, but students had a low score for Student Access and Use (-0.99) because they were not allowed to use their laptops at home for learning. In other schools, such as MS 17 and MS 18, students reported higher levels of technology access and use even though strong implementation supports were not in place, and their teachers' levels of Classroom Immersion were low.

Campus-level results for the Implementation Index displayed in Figure 3.12 illustrate the variation in the levels of Technology Immersion for the 21 middle schools in the fourth project year. Results for the Implementation Index combined with evidence from standards-based scores suggest that about a quarter of middle schools (6), with Implementation Index scores ranging from 0.39 to 2.58 standard deviations above the mean, had a stronger presence of the components of Technology Immersion compared to other schools, and thus a higher level of implementation that more nearly approximated expected standards.

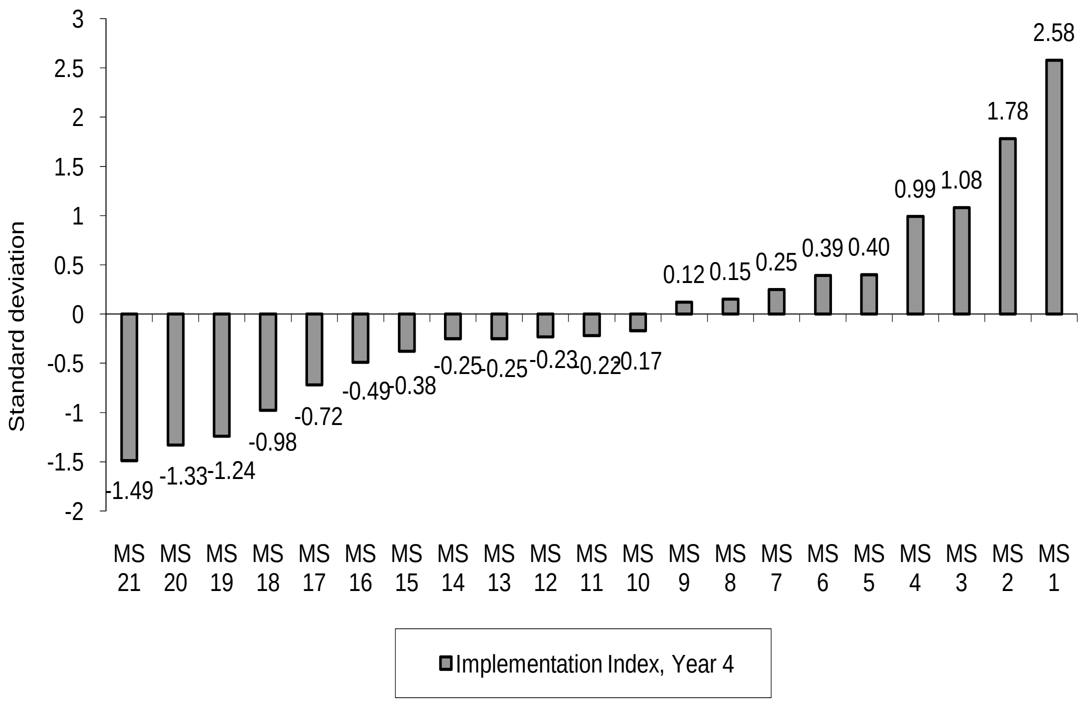


Figure 3.12. Campus means for 21 immersion middle schools (MS) on the Technology Immersion Implementation Index (standardized scores [*z* scores] with a mean of 0 and a standard deviation of 1.0).

Conclusions

This chapter described the components of Technology Immersion, as defined by the TEA and operationalized through Technology Immersion packages. Over three project years, we measured implementation using a two-part approach: (a) designation of standards defining four levels of immersion (*minimal*, *partial*, *substantial*, and *full),* and (b) calculation of standardized implementation indices (*z* scores). Both types of scores provide evidence relative to the strength of supports for immersion, and the extent of teachers' classroom immersion and students' technology access and use. Major findings are the following.

- Mean immersion standard scores revealed small yearly increases across most of the implementation support components (Leadership, Teacher Support, Parent/Community Support, and Professional Development) as well as increases in teachers' overall level of Classroom Immersion. In contrast, the level of Student Access and Use declined across years.
- Despite improvements, mean fourth-year immersion standard scores (ranging from 2.69 to 3.19) showed that many schools needed stronger supports, especially in the areas of parent and community support for technology use, technical supports that addressed obstacles to technology use, and professional development for teachers.
- Consistent with the second and third project years, core-subject teachers at a majority of schools reported only partial levels of Classroom Immersion in the fourth year. Teachers' mean scores at a fifth of schools, however, revealed substantial levels of Classroom Immersion.
- As a whole, the standards-based implementation scores for Classroom Immersion increased slightly across years (from 2.48 to 2.69). Standard scores for four of the five elements of Classroom Immersion showed somewhat stronger implementation in the fourth year, with the largest increase for teachers' use of technology for Professional Productivity and the smallest change for Technology Integration. The frequency with which teachers had students in their classrooms use technology for learning activities (Student Activities) remained relatively stable across years.
- Students' access to and use of laptops for learning within and outside of school continued to fall well short of expectations in the fourth year. The percentage of schools with partial levels of access and use decreased across years (76%, 68%, and 57%), while the percentage of schools with minimal access and use increased (24%, 32%, and 43%).
- Students' opportunities to use their laptops for learning both within classrooms and outside of school were affected by several factors, including mainly time lost for repairs due to aging laptops, schools that opted to transfer laptops from individual students to carts or classroom sets, schools that restricted students' use of laptops outside of school, and teachers' preferences regarding laptop use. Year-to-year comparisons indicated that the mean implementation level for Laptop Access Days increased between the third and fourth project years (from 2.50 to 2.64), whereas the yearly mean implementation levels for Core-Content Learning (2.07, 2.12, and 1.95) and Home Learning (1.75, 1.84, and 1.63) decreased across years.
- Implementation indices (*z* scores) described each school's level of implementation for the components of Technology Immersion. Fourth-year evidence from immersion standard scores and the Implementation Index, a composite score measuring the overall presence of immersion components, indicated that about a quarter of middle schools (6) had a much stronger presence of the immersion components compared to other schools. Thus, these schools had a higher level of immersion that more nearly approximated expected implementation standards.

Despite low levels of implementation at many campuses, report chapters to follow demonstrate that Technology Immersion can positively affect teachers and students in many ways even at lower levels of implementation.

4. Effects of Technology Immersion on Teachers and Teaching

In the theoretical model, researchers posited that high quality implementation of Technology Immersion would lead to teachers who have greater technology proficiency, use technology more for their own professional productivity, hold a more favorable pedagogical orientation toward technology, and collaborate more often with their peers to advance teaching and learning through technology. Moreover, teachers in schools that achieve higher levels of school and classroom immersion will have students who use technology more often in their classrooms and will use laptops as a tool to increase the intellectual challenge of lessons.

Contrary to expectations, results reported in Chapter 3 revealed that school-level supports for Technology Immersion generally did not meet full implementation standards, and accordingly, teachers at many treatment schools reported just partial levels of Classroom Immersion. Additionally, as noted in the methodology chapter, control schools began to plan for Technology Immersion in the third year, and in the fourth year, most of the control teachers had personal laptops, digital teaching and learning resources, and opportunities for technology-related professional development, and students in many control classrooms had wireless laptops. Recognizing the less-than-ideal experimental conditions, we have investigated the effect of Technology Immersion on treatment teachers, given that the fidelity of implementation varied across schools and control teachers benefited from many elements of the treatment.

Findings on the effects of immersion on teacher-mediating variables come from online surveys of teachers completed in fall 2004 (N = 1,271) and again in spring 2005 (N = 1,144), 2006 (N = 1,175), 2007 (N = 1,208), and 2008 (N = 1,159). Response rates ranged from 87% to 98% across survey administrations, with only small differences between comparison groups. Teachers responded to survey items measuring seven variables pertinent to their technology knowledge and skills (Technology Proficiency and Professional Productivity), ideological views (Technology Integration, Learner-Centered Instruction, and Resistance to Integration), frequency of student activities with technology (Student Classroom Activities), and interactions with peers on technology issues (Collaboration). Cronbach's alpha reliability coefficients for the scale scores ranged from 0.66 to 0.98. (See Appendix C for technical details.)

Researchers also conducted classroom observations during site visits at each of the treatment and control schools to gather information on instructional practices and changes across time. Classroom observations focused incrementally on the teachers of Cohorts 1, 2, and 3 students. We conducted observations in a sample of sixth-grade classrooms in fall 2004 and spring 2005, sixth- and seventh-grade classrooms in spring 2006, and sixth-, seventh-, and eighth-grade classrooms in spring 2007 and 2008.

Teacher Mediating Variables—HLM Analysis

An advantage of a longitudinal study is the potential to study the nature of teacher change. The development of hierarchical linear models (HLM) has provided statistical tools for studying rates of change using measurements from multiple time points (Raudenbush & Bryk, 2002). For this study, we measured teacher variables on five occasions (fall 2004 through spring 2008). Our analytical sample included 2,137 teachers who taught at schools at some point during four implementation years, with

1,046 in 21 Technology Immersion schools and 1,091 in 21 control schools. Thus, we included teachers in the analyses even if they were not measured at all five time points. Because multilevel regression models do not assume equal numbers of observations (i.e., occasions of measurement), respondents with missing data can remain in the analysis (Hedeker, 2004; Hox, 2002). HLM, however, requires complete data at the teacher and school levels, so teachers were omitted if, for example, they were missing demographic information such as ethnicity. Our analytic approach mitigated problems associated with the substantial loss of teachers from analyses due to generally high teacher attrition rates each year of the study and varying teacher turnover rates across schools. For example, while the overall annual average teacher turnover rate ranged from 14% to 16%, individual school annual turnover rates varied from about 6% to about 42%.

The analyses that follow contrast immersion and control teachers' individual growth trajectories for each of the seven scales described above. We analyzed effects using three-level hierarchical growth models. HLM growth models produce teacher- and school-specific effects (i.e., the extent which the survey scores vary across time, teachers, and schools). In our models, we hypothesize that school poverty is related to teachers' initial status and yearly growth rate. This supposition stems from an investigation of the implementation of Technology Immersion indicating that a higher concentration of economically disadvantaged students in a school is negatively associated with stronger levels of school and classroom immersion. Similarly, other research reviews confirm the negative effects of school poverty on school reform efforts (Desimone, 2002) and student achievement (Sirin, 2005). Since Technology Immersion Pilot (TIP) grants targeted high-needs schools, the percentages of disadvantaged students were generally high across most of the study's schools. Even so, school poverty concentrations varied substantially (ranging from 31% to 100%). The statistical model is described below.

Level 1: Repeated-Measures Model

Level 1 is a repeated-measures model (i.e., survey time within teachers) that enables us to capture key features of growth (e.g., initial status, rate of change). In the model, Y_{tij} is the survey scale score at year t for teacher i in school j. Survey Time is the point at which teachers completed the online surveys (0=fall 2004, 1=spring 2005, 2=spring 2006, 3=spring 2007, 4=spring 2008). The key parameters in the model are π_{0ij} and π_{1ij}. The coefficient π_{0ij} represents the "initial status" (that is, the initial survey scale score) for teacher i in school j in fall 2004, and π_{1ij} is the growth rate (rate of change) for teacher i in school j per school year. The e_{tij} is the error term (within-teacher measurement error) assumed to be normally distributed with a mean of 0 and a constant variance. Thus, at level 1 the model is

$$Y_{tij} = \pi_{0ij} + \pi_{1ij}\,(Survey\ Time)_{tij} + e_{tij}.$$

Level 2: Teacher-Level Model

The Level 2 model (between-teachers model) allows us to determine differences between teachers in features of growth (e.g., initial status, rate of change). In the teacher-level model, π_{0ij} is the teacher's initial survey scale score and π_{1ij} is the teacher's rate of growth per school year. In the model, β_{00j} represents the mean initial status within school j, and β_{10j} is the mean yearly rate of teacher change within school j. The r_{0ij} and r_{1ij} are residuals (i.e., random effects). At level 2, the model is

$$\pi_{0ij} = \beta_{00j} + r_{0ij}$$
$$\pi_{1ij} = \beta_{10j} + r_{1ij}.$$

Level 3: School-Level Model

At the school level (level 3), we examined how teachers' initial status and growth varied across schools as a function of school-level random effects (μ_{00j} and μ_{10j}) as well as school conditions, including immersion status and school poverty. That is, we hypothesized that being in an immersion school is positively related to teachers' growth on technology-related scores, after controlling for the poverty level of the school. Thus, we pose the following school-level model:

$$\beta_{00j} = \gamma_{000} + \gamma_{001}(Immersion\ Status)_j + \gamma_{002}(School\ Poverty)_j + \mu_{00j}$$
$$\beta_{10j} = \gamma_{100} + \gamma_{101}(Immersion\ Status)_j + \gamma_{102}(School\ Poverty)_j + \mu_{10j}.$$

In the model, β_{00j} is the mean initial status for teachers in school j and γ_{000} is the overall mean initial status (grand mean); β_{10j} is the mean teacher growth rate in school j and γ_{100} is the overall mean teacher growth rate. Immersion status is an indicator variable with a value of 0 for a control school and a value of 1 for an immersion school. School poverty is a continuous variable with percentages ranging from ranging from 31% to 100%, with a mean of 68.5%. The coefficients γ_{001} and γ_{101} represent the direction and strength of association of immersion status and school-level initial status.

Effects of Immersion on Teachers

After adjusting for school poverty, Technology Immersion had a statistically significant effect on teachers' rates of growth for four of seven technology-related variables (Table 4.1). This was a notable change from the significant effect on teachers' growth for six technology-related variables in the first through third project years. Teachers at Technology Immersion schools in the fourth year, on average, had significantly steeper growth trends than teachers at control schools for Technology Proficiency and Professional Productivity, one measure of teachers' ideology (Learner-Centered Instruction), and the frequency of Student Classroom Activities (with technology). In contrast to previous results, there was no significant difference between the treatment and control teachers for measures of their growth in Technology Integration or Collaboration with their colleagues.

Table 4.1. Immersion Effects on Estimated Mean Growth Rates for Teacher Variables

		Statistics for Teachers in Immersion Schools with Average School Poverty[c]			
	Immersion Effect Net of School Poverty	Average Estimated Initial Status Fall 2004	Yearly Growth Rate	Average Estimated Score Spring 2008	Yearly Growth Rate for Control Teachers
Technology Proficiency[a]	Yes	4.53	0.29***	5.69	0.15***
Professional Productivity[b]	Yes	2.95	0.18***	3.67	0.11***
Ideology					
Technology Integration[a c]	No	3.29	0.40	4.89	0.30
Learner-Centered Instruction[a]	Yes	3.72	0.31***	4.96	0.20***
Resistance to Integration[a]	No	2.17	0.04	2.33	0.01
Student Classroom Activities[b]	Yes	2.02	0.17***	2.70	0.07***
Collaboration[b]	No	2.44	0.07	2.72	0.06***

Source: Online teacher surveys conducted in fall 2004 and spring 2005, 2006, 2007, and 2008.
$*p < .05$. $**p < .01$. $***p < .001$.
[a] Items measured on a 7-point scale. [b] Items measured on a 5-point scale.
[c] Controls for the effect of differences in initial status on the Technology Integration growth rate.

Control teachers, who were exposed to elements of the Technology Immersion model in the fourth year, had significantly positive growth trends for five technology-related variables. Although control teachers' yearly growth rates were significantly less steep than rates for immersion teachers, the introduction of technology resources in control schools had a positive effect on teachers' Technology Proficiency, use of technology for Professional Productivity, affiliation with Learner-Centered Instructional ideologies, and the frequency of technology-related Student Classroom Activities and Collaboration with peers. Sections to follow explain the nature of teacher change, with Tables 4.2, 4.3, and 4.4 providing school-level statistics for the HLM analyses of immersion effects.

Technology Knowledge and Skills

Texas Technology Applications Standards require *all* teachers to master and use technology-related terminology, concepts, and strategies, and to use tools to accomplish a range of tasks (e.g., communicate with diverse audiences and analyze electronic information). Thus, our online surveys included measures of teachers' Technology Proficiency and Professional Productivity. For Technology Proficiency, teachers rated their skills in using various technology applications on a 7-point scale ranging from 1 (*not true of me now*) to 7 (*very true of me now*). The proficiency scale included 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) and items related to classroom instruction (e.g., using the computer for presentations or creating a lesson plan or unit incorporating technology).

HLM statistics in Table 4.2 show that immersion teachers grew in technology proficiency at a significantly faster rate (0.29 scale-score point per year) than control teachers (0.15 point per year). Immersion teachers began with slightly lower mean proficiency scores than control teachers in fall 2004, but they surpassed control teachers in spring 2005 and continued to widen the proficiency gap during the next three school years.

Table 4.2. Immersion (Fixed) Effect Analyses for Teacher Technology Knowledge and Skills Variables

Dependent variable and predictor	Technology Proficiency		Professional Productivity	
	Gamma Coefficient	t-value	Gamma Coefficient	t-value
Initial status (fall 2004)	4.692	58.26***	3.011	51.53***
Immersion	-0.165	-1.48	-0.062	-0.80
School Poverty	0.001	0.16	0.001	0.57
Growth rate	0.147	10.53***	0.110	12.17***
Immersion	0.138	6.06***	0.069	4.92***
School Poverty	-0.002	-3.23**	0.000	-0.66

$^{\dagger}p < .10$. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Similar to previous years, teachers who taught at immersion and control schools with higher levels of school poverty (percentages of economically disadvantaged students) had significantly slower rates of growth for Technology Proficiency. For each percentage point increase in school poverty, teachers had a 0.002 scale-score decrease in proficiency. Thus, a 20% decrease in school poverty predicted a 0.04 point increase in teachers' yearly growth in proficiency (i.e., 20 *x* 0.002); a 20% increase in school poverty predicted a 0.04 point decrease in teachers' yearly growth. As the level of school poverty increases, the teacher proficiency gap widened.

Teachers also rated the frequency with which they used technology for Professional Productivity on a 5-point scale ranging from 1 (*never*) to 5 (*almost daily*). Productivity items, for example, measured teachers' use of technology for administrative, classroom management, communication, and instructional purposes. Similar to findings for Technology Proficiency, teachers at immersion schools had significantly steeper rates of growth than control teachers in the use of technology to improve their productivity. The estimated yearly mean growth trajectories for immersion and control teachers in schools with average poverty were 0.18 and 0.11 scale-score points per year, respectively. Teachers working in schools with higher percentages of disadvantaged students grew in productivity at similar rates.

Figure 4.1 compares the growth in technology knowledge and skills for treatment and control teachers. As the figure illustrates, immersion teachers grew in Technology Proficiency and Professional Productivity at a faster rate than control teachers, but control teachers had a significantly positive growth trend for both of the technology competency indicators.

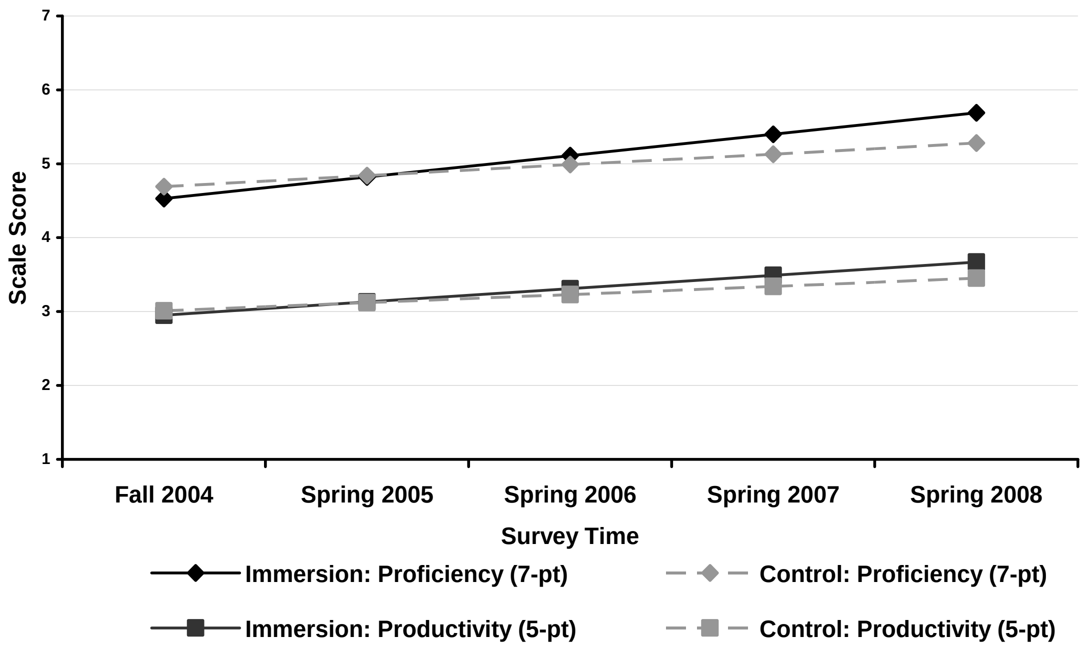


Figure 4.1. Estimated mean growth trajectories for treatment and control teachers working in schools with average levels of school poverty on Technology Proficiency and Professional Productivity indicators (ratings on either 5-point or 7-point scales).

Ideology

Teachers also responded to items measuring their ideological views relative to technology integration and constructivist practices on a 7-point scale, ranging from 1 (*not true of me now*) to 7 (*very true of me now*). Items from the Levels of Technology Implementation (LoTi) Questionnaire (Moersch, 2001) measured three latent variables (Technology Integration, Learner-Centered Instruction, and Resistance to Integration). HLM results detailed in Table 4.3 and illustrated in Figure 4.2 show that at both immersion and control schools, teachers on average became more positive towards innovative technology practices across time.

The Technology Integration scale included items gauging teachers' actions supporting curricular and instructional infusion of technology. For example, teachers indicated the extent to which computer-related activities enabled them to support students' authentic problem solving or to promote critical thinking. Coefficients reported in Table 4.3 show that teachers in immersion schools had a positive rate of change for Technology Integration but the growth rate was not significantly steeper than the growth of control teachers. The mean estimated growth trajectory for immersion teachers who worked in schools having average levels of school poverty was 0.40 scale-score point per year compared to 0.30 scale-score point for control teachers. This result differed from results for previous study years showing that teachers at Technology Immersion schools grew significantly faster than control teachers in practices supporting Technology Integration.

Table 4.3. Immersion (Fixed) Effect Analyses for Teacher Ideology Variables

	Technology Integration[a]		Learner-Centered Instruction		Resistance to Integration[b]	
Dependent variable and predictor	Gamma Coefficient	*t*-value	Gamma Coefficient	*t*-value	Gamma Coefficient	*t*-value
Initial status (fall 2004)	2.847	38.95***	3.683	56.37***	2.463	44.57***
Immersion	0.445	4.61***	0.036	0.39	-0.295	-4.24***
School Poverty	0.010	3.50**	0.006	2.62*	-0.003	-1.75†
Growth rate	0.002	0.00	0.199	11.75***	0.011	0.86
Immersion	0.105	1.14	0.110	3.42**	0.024	1.03
School Poverty	-0.005	-2.30*	-0.002	-2.08*	0.002	3.69**
Initial status	0.103	0.55	--	--	--	--

†$p < .10$. *$p < .05$. **$p < .01$. ***$p < .001$.

[a]Technology Immersion teachers had significantly higher initial Technology Integration scores. A latent variable regression, controlling for the effect of this initial difference on the growth rate, indicated that the immersion effect was non-significant after controlling for initial differences. Thus, the coefficients from the latent variable regression model are reported here.

[b] Technology Immersion teachers had significantly lower initial Resistance to Integration scores. A latent variable regression, controlling for the effect of this initial difference on the growth rate, indicated that the immersion effect was a non-significant predictor of the growth rate with and without controlling for initial differences. Thus, the coefficients from the original growth model are reported here.

Consistent with previous years, teachers at immersion schools compared to control grew at a significantly faster rate in their affiliations with principles of Learner-Centered Instruction. Across survey administrations, immersion teachers reported increasingly higher ratings for items describing pedagogical practices such as having students establish individual learning goals, emphasizing experiential learning, and providing real-world experiences. The estimated yearly growth in the adoption of learner-centered practices for immersion and control teachers in schools with average poverty was 0.31 and 0.20 scale-score points, respectively. Teachers in schools with higher concentrations of school poverty had significantly slower rates of growth relative to both technology integration and learner-centered practices.

For the Resistance to Integration scale, teachers expressed their strength of association with items suggesting that classroom computers are not a priority, are not a necessary part of instruction, and are not practical for students. Contrary to the two ideological indicators discussed above, there was little change in the growth rate on the Resistance to Integration scale for either immersion or control teachers. Scores indicated that teachers, on average, expressed a relatively low level of resistance to technology integration, and their level of resistance remained fairly constant across years. Still, teachers in schools with higher levels of student poverty expressed significantly greater resistance to technology.

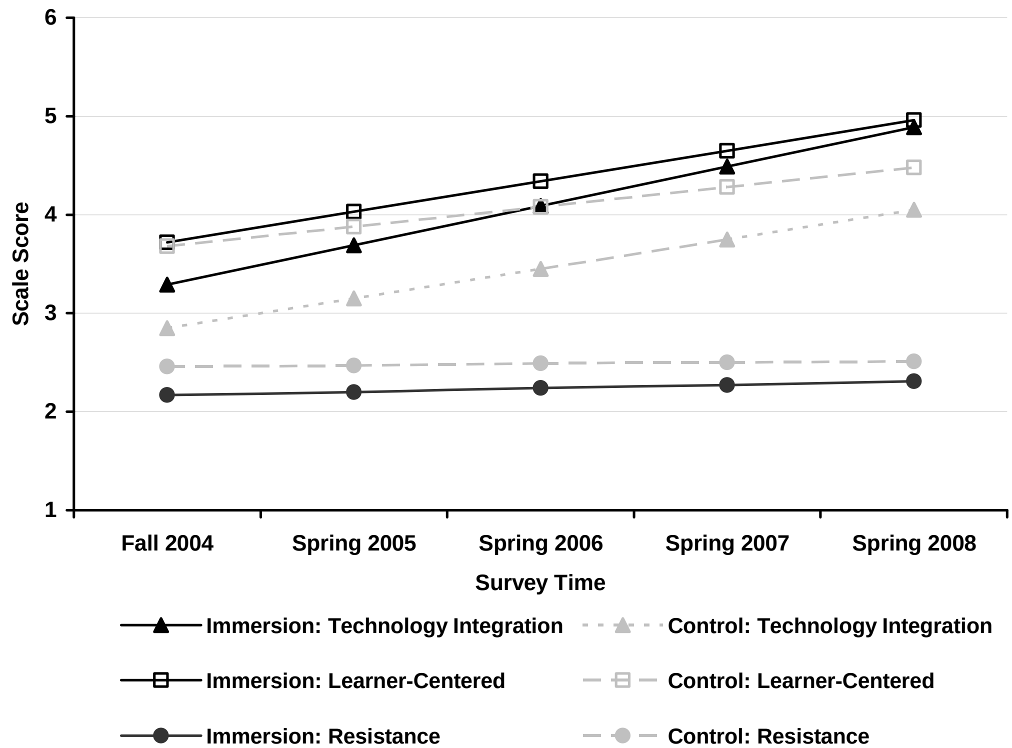


Figure 4.2. Estimated mean growth trajectories for treatment and control teachers working in schools with average levels of school poverty on Ideology indicators: Technology Integration, Learner-Centered Instruction, and Resistance to Integration (ratings on 7-point scales).

Student Classroom Activities and Teacher Collaboration

Table 4.4 provides HLM statistics for measures of teachers' classroom activities and collegial collaboration. The Student Classroom Activities scale provided an estimate of the frequency—on a 5-point scale ranging from 1 (*never*) to 5 (*almost daily*)—with which teachers had students in their typical class use technology in various ways. For example, teachers might have students use technology for writing, learning and practicing skills, communication, or Internet research. As expected, given the greater availability of laptops at immersion schools, teachers at treatment schools had a significantly faster growth rate for Student Classroom Activities (0.17 and 0.07 scale-score points per year, respectively, for immersion and control teachers in schools with average poverty). School poverty was a significantly negative predictor of teachers' growth in the frequency of students' classroom activities involving technology.

Even though treatment teachers had their students use technology in classrooms more frequently across years, estimated mean scores displayed in Figure 4.3 show that by spring 2008, teachers, on average, had students use various technology applications in their classes infrequently (about once or twice a month, $M = 2.72$). Students in schools with higher concentrations of economically disadvantaged students used technology even less often. Students in control teachers' classrooms, on average, used technology applications a few times a year ($M = 2.15$ in spring 2008).

Table 4.4. Immersion (Fixed) Effect Analyses for Student Classroom Activities and Teacher Collaboration Variables

Dependent variable and predictor	Student Classroom Activities[a]		Teacher Collaboration[a]	
	Gamma Coefficient	*t*-value	Gamma Coefficient	*t*-value
Initial status (fall 2004)	1.858	39.52***	2.292	48.04***
Immersion	0.161	2.65*	0.143	2.29*
School Poverty	0.004	2.56*	0.004	2.30*
Growth rate	0.073	5.90***	0.055	3.97***
Immersion	0.101	5.60***	0.018	0.95
School Poverty	-0.001	-2.51*	0.000	0.15

†$p < .10$; *$p < .05$; **$p < .01$; ***$p < .001$.

[a] Treatment teachers had significantly higher initial scores for student activities and collaboration. Latent variable regressions, controlling for the effects of initial differences on growth rates, indicated that immersion was a significant predictor of growth rates with and without controlling for initial differences. Thus, the coefficients from the original growth models are reported here.

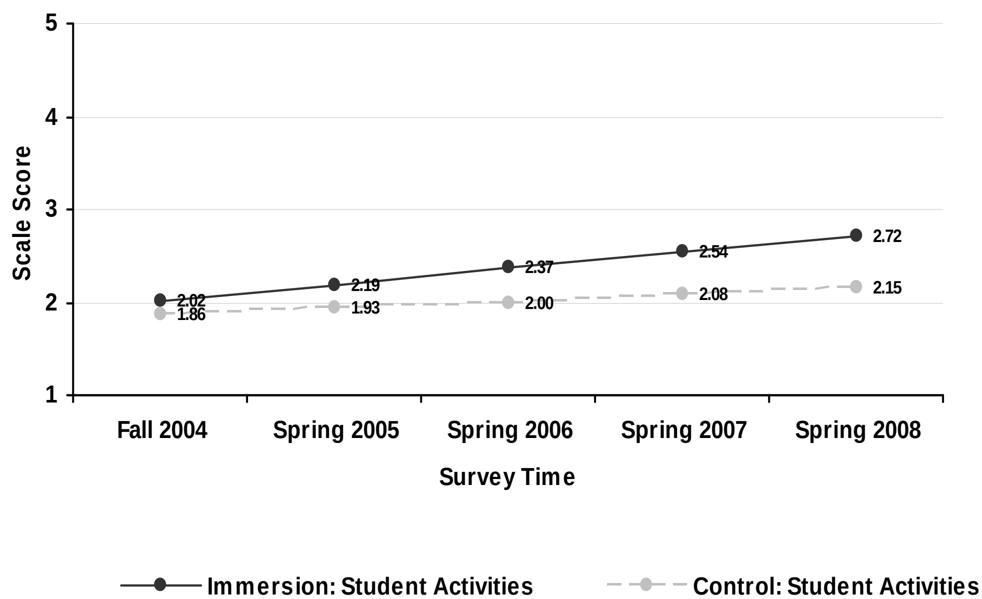


Figure 4.3. Estimated mean growth trajectories of treatment and control teachers working in schools with average levels of school poverty for Student Classroom Activities (ratings on 5-point scale).

We also reasoned that a greater abundance of technology resources and opportunities for shared professional development would lead to stronger teacher connections. Accordingly, the Collaboration scale measured teacher interactions with colleagues that supported improvements in instructional practices, such as coaching and mentoring, collectively developing technology lessons, and exchanging information about their students. Contrary to previous years, there was no significant immersion effect on teachers' yearly growth rate for Collaboration. Immersion and control teachers had similar growth trends relative to collegial interactions (0.07 and 0.06 scale-score points, respectively). Campus poverty had a negligible association with teacher collaboration.

Effects of Immersion on Classroom Practice

To further understand teachers' instructional practices, researchers conducted classroom observations in samples of core-subject classrooms (reading/English language arts, mathematics, science, and social studies). We added teachers at higher grade levels each year so that the observed teachers taught students included in the three cohorts of students followed in the study. In fall 2004 and spring 2005, we observed sixth-grade teachers. The classroom sample included observations of sixth- and seventh-grade teachers in spring 2006, and observations of sixth-, seventh-, and eighth-grade teachers in spring 2007 and 2008. Each year, we purposefully selected teachers to represent grade levels and subject areas, and when possible, we selected teachers who had been observed in previous years.

Classroom observations involved either single observers (about 75% of classrooms) or pairs of observers (about 25% of classrooms). Paired observations permitted the calculation of inter-observer agreement. In fall 2004, researchers observed 125 classrooms (60 treatment and 65 control) in half of the schools. Subsequently, we conducted observations in all schools. We observed 206 classrooms in 2005 (105 treatment and 101 control), 217 classrooms in 2006 (114 treatment and 103 control), 194 classrooms in 2007 (95 treatment and 99 control), and 230 classrooms in 2008 (117 treatment and 113 control). At small campuses, researchers observed nearly all core-content teachers; at larger campuses, we observed a representative sample of classrooms.

Across data-collection periods, observations at treatment and control schools included nearly equal proportions of teachers by subject-area taught, gender, highest degree earned, and years teaching experience. Observations included somewhat more English language arts and reading teachers (28% to 33% of observed teachers), and somewhat fewer mathematics teachers (22% to 29%), social studies teachers (19% to 27%), and science teachers (13% to 24%). Variations reflected our interest in documenting the instructional practices of teachers whose students were included in cohorts being tracked across years and their TAKS-tested subject areas.

During observations, data collectors used the Observation of Teaching and Learning (OTL) instrument to record descriptive information about the classroom environment, and to make time-interval ratings for 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, & Wehlage, 1995). One section of the OTL included 5-point rating scales for four standards 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.
- *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.* Students make connections between knowledge and either public problems or personal experience (Newmann et al., 1995).

An aggregate score across three of the four standards was used as an overall measure of the Intellectual Challenge of instruction for each teacher. The score for Substantive Conversation was omitted from the composite score because ratings were highly influenced by the organizational structure of lessons. Specifically, lessons involving teacher-directed discussions typically yielded more public conversations, and thus, better opportunities to gather evidence on conversational exchanges than lessons with students working in small groups or individually. Additionally, to enhance observer agreement for OTL ratings, we conducted training sessions for researchers immediately before each series of site visits began, except for the fourth year. Across years, we utilized Many-Facet Rasch Measurement (Linacre, 2004) to adjust the measure of Intellectual Challenge for the relative severity (or leniency) of each observer during analyses.

Table 4.5 reports the adjusted composite Intellectual Challenge scores for immersion and control teachers across five data-collection periods. When researchers conducted baseline observations in fall 2004, sixth-grade control teachers' mean Intellectual Challenge score (1.88) was significantly higher than immersion teachers' instructional score (1.62). The difference represented a moderate effect size (ES = -0.33) favoring control teachers. Thus, control teachers initially engaged students in lessons that required a higher level of thinking, delved into topics more thoroughly, and made stronger connections with students' background experiences and the world beyond the classroom. On the contrary, in spring 2005, sixth-grade teachers' lessons at immersion schools received a slightly higher mean Intellectual Challenge score (1.87) than control teachers' instruction (1.81). The difference between the groups, however, was statistically insignificant.

Table 4.5. Adjusted Intellectual Challenge Scores for Treatment and Control Teachers

	Treatment			Control					Effect
Group	*N*	Mean	*SD*	*N*	Mean	*SD*	*t*-value	*p*	Size
Fall 2004	60	1.62	0.71	65	1.88	0.87	-1.84	0.07†	-0.33
Spring 2005	106	1.87	0.93	101	1.81	0.90	0.48	0.63	0.07
Spring 2006	114	1.82	0.75	103	1.77	0.76	0.47	0.64	0.07
Spring 2007	95	2.06	0.80	99	1.91	0.77	1.28	0.20	0.19
Spring 2008	117	2.06	0.78	113	2.00	0.76	0.59	0.56	0.08

Notes. Observations at 21 immersion and 21 control schools. Intellectual Challenge of Instruction scores could range from 1 (low challenge) to 5 (high challenge). The rating for Substantive Conversation was deleted from the composite score. †Difference is statistically significant at the 0.10 level. Effect size is Cohen's *d*.

In spring 2006, lessons observed in sixth- and seventh-grade teachers' classrooms at immersion schools received a slightly higher mean Intellectual Challenge score (1.82) than control teachers' lessons (1.77), but not by a statistically significant margin. In spring 2007, lessons delivered by sixth-, seventh-, and eighth-grade teachers at immersion schools had a notably higher mean level of Intellectual Challenge (2.06) compared to control teachers' instruction (1.91). Although the difference between groups was statistically insignificant, the small, positive effect size (0.19) showed that instruction at immersion schools was a bit more challenging. In spring 2008, differences between the immersion and control teachers narrowed. The lessons observed in sixth through eighth grade classrooms at immersion schools received a slightly higher mean Intellectual Challenge score (2.06) compared to control teachers' lessons (2.00). The difference between groups was statistically insignificant and the effect size was very small (0.08).

Table 4.6 summarizes findings across the data collection periods for each of the Intellectual Challenge domains. Effect sizes show that control teachers' instruction in fall 2004, compared to immersion teachers, had a higher mean level of intellectual challenge for each of the four standards. However, in spring 2005, immersion teachers' lessons received higher ratings for Higher Order Thinking (ES =

0.18) and Depth of Knowledge (ES = 0.09). In spring 2006 and 2007, immersion teachers' lessons, compared to control teachers, received higher Intellectual Challenge scores for each of the four standards. Effect sizes indicated that immersion teachers had a greater instructional emphasis on Higher Order Thinking (0.22 in 2006, 0.28 in 2007) and Connections beyond the Classroom (0.06 in 2006, 0.18 in 2007). In 2008, differences between the intellectual rigor of immersion and control teachers' lessons resembled findings for spring 2005 (the end of the first implementation year). Although group differences were statistically insignificant, immersion teachers' instruction had a greater emphasis on Higher Order Thinking (ES = 0.22) and Depth of Knowledge (ES = 0.19), but control teachers' lessons involved more Substantive Conversation (ES = -0.04) and Connections Beyond the Classroom (ES = -0.19).

Table 4.6. Adjusted Intellectual Challenge Scores for Immersion and Control Teachers, by Dimension and Year

	Treatment		Control				*Effect*
Standard	Mean	*SD*	Mean	*SD*	*t-value*	*p*	*Size*
Fall 2004 (Baseline)							
Higher Order Thinking	1.67	1.02	1.80	1.03	-0.73	0.470	-0.13
Depth of Knowledge	1.60	0.94	1.85	1.05	-1.38	0.171	-0.25
Substantive Conversation	1.33	0.77	1.40	0.75	-0.49	0.625	-0.09
Connections Beyond the Classroom	1.35	0.66	1.48	0.83	-0.94	0.349	-0.17
Spring 2005							
Higher Order Thinking	1.89	1.04	1.71	1.00	1.21	0.227	0.18
Depth of Knowledge	1.83	1.07	1.73	1.06	0.65	0.518	0.09
Substantive Conversation	1.40	0.74	1.44	0.84	-0.36	0.720	-0.05
Connections Beyond the Classroom	1.79	1.01	1.82	1.05	-0.22	0.827	-0.03
Spring 2006							
Higher Order Thinking	1.91	0.93	1.71	0.90	1.64	0.104	0.22
Depth of Knowledge	1.85	0.88	1.83	0.97	0.13	0.899	0.02
Substantive Conversation	1.46	0.73	1.45	0.92	0.09	0.932	0.01
Connections Beyond the Classroom	1.63	0.91	1.58	0.85	0.41	0.681	0.06
Spring 2007							
Higher Order Thinking	2.20	1.05	1.92	0.92	1.98	0.049*	0.28
Depth of Knowledge	2.15	0.98	2.01	0.98	0.97	0.332	0.14
Substantive Conversation	1.46	0.77	1.38	0.70	0.75	0.452	0.11
Connections Beyond the Classroom	1.75	0.97	1.58	0.88	1.29	0.198	0.18
Spring 2008							
Higher Order Thinking	2.27	1.06	2.04	1.00	1.69	0.092	0.22
Depth of Knowledge	2.32	1.02	2.14	0.93	1.43	0.156	0.19
Substantive Conversation	1.40	0.74	1.50	0.72	-0.97	0.332	-0.04
Connections Beyond the Classroom	1.65	0.90	1.83	1.00	-1.45	0.148	-0.19

Note. Rating scales developed by Newmann, Secada, & Wehlage (1995) ranged from 1 to 5. Teacher counts: fall 2004 (60 immersion and 65 control), spring 2005 (105 immersion and 101 control), spring 2006 (114 immersion and 103 control), spring 2007 (95 immersion and 99 control), and spring 2008 (117 immersion and 113 control).
*Statistically significant difference. Effect size is Cohen's *d*.

In general, the introduction of technology resources (the treatment) into control teachers' classrooms has biased measures of differences between treatment and control groups. Nevertheless, longitudinal effect size trends suggest that the intellectual rigor of treatment teachers' instruction has improved somewhat over time. The introduction of technology resources in control classrooms seems to have had a similarly positive influence on control teachers' instruction. Multi-year findings from observations in middle-school classrooms also raise concerns about the intellectual rigor of students' assigned tasks. Results for *all* observed classrooms indicated that lessons in middle-school core classes generally failed to intellectually challenge students, with average ratings about 2.3 or less on the 5-point intellectual challenge of instruction scales.

Conclusions

We found that working in treatment schools that had been implementing Technology Immersion across four school years had a significantly positive effect on teachers' growth in a number of areas. Similarly, the acquisition of immersion resources such as teacher laptops, digital resources, professional development, and student laptops during the past two school years spurred control teachers' growth in technology competency and use. Key findings are the following:

- Immersion teachers grew in Technology Proficiency and in their use of technology for Professional Productivity at significantly faster rates than control teachers.
- Immersion teachers expressed increasingly stronger ideological affiliations with Learner-Centered Instruction than control teachers. At the same time, immersion teachers reported generally low Resistance to Integration.
- Students in immersion classrooms used technology applications significantly more often than control students for core-subject learning activities (Student Classroom Activities).
- Across both treatment and control campuses, school poverty was negatively associated with teachers' growth on several technology-related indicators. Notably, teachers in schools with above average levels of school poverty grew in Technology Proficiency at a significantly slower rate, and expressed significantly weaker affiliations with Technology Integration and Learner-Centered Instruction, and stronger Resistance to Integration. Teachers in schools with greater school poverty also had their students use technology applications significantly less often in their classrooms (Student Classroom Activities).
- The introduction of elements of the Technology Immersion model in control schools had a significantly positive effect on control teachers. In the fourth year, control teachers had statistically significant growth trends for Technology Proficiency, Professional Productivity, Learner-Centered Instruction, Student Classroom Activities (with technology), and Collaboration (with peers). Teachers' growth has narrowed the gap between treatment and control groups.
- Longitudinal effect size trends suggest that the availability of laptop computers and digital resources has allowed students in Technology Immersion schools to experience more intellectually demanding work. Nevertheless, ratings of the Intellectual Challenge of classroom instruction indicated that the intellectual demand of core-subject lessons was typically low across all middle-school classrooms observed.

5. Effects of Technology Immersion on Students and Learning

In the theoretical model of Technology Immersion, we assumed that improved school and classroom environments for technology would lead to more technology-adept teachers who use technology more effectively for their own purposes and have students use technology more often and for more intellectually challenging lessons. We also reasoned that students who experienced improved school and classroom conditions would acquire greater technology proficiency, use technology more often for learning, collaborate more often with peers, have opportunities for more rigorous and relevant school work, feel more strongly engaged in school and learning, and become more self-directed. Consistent with our suppositions, findings reported in Chapter 4 confirmed that teachers at immersion schools, in comparison to their control counterparts, are more technically proficient and productive, have their students use technology more often in class, and provide more intellectually demanding assignments. We investigate in this chapter the effects of Technology Immersion on students and their learning experiences.

Immersion Effects on Student Mediating Variables

Data on student mediating variables come from paper-and-pencil surveys (*Student Questionnaire* and *Style of Learning Inventory*) completed by students as baseline measures in fall of their sixth-grade year and again as post-measures in spring of each project year. Cohort 2 (eighth graders) and Cohort 3 (seventh graders) completed surveys in the fourth year. Cohort 1 students who attended various high schools as ninth graders in the fourth year did not complete surveys. The *Student Questionnaire* measured students' technology proficiency, technology use, and views on technical problems. The questionnaire also gauged students' opportunities to work with peers in small groups and their satisfaction with school. The *Style of Learning Inventory* (*SLI*) measured various aspects of students' self-directed learning. Overall, response rates for the *Student Questionnaire* were in the 80% to 90% range across time periods, with only slight differences in response rates between cohorts and comparison groups. Response rates for the *SLI* ranged from 77% to 89% across administrations. There were only slight differences in *SLI* response rates between cohorts and comparison groups. (See additional detail in the methodology chapter.)

Immersion effects were estimated for six scales: Classroom Activities, Small-Group Work, Technical Problems, Technology Proficiency, Self-Directed Learning (Cohort 2 only), and School Satisfaction. Cronbach's alpha coefficients (measures of internal consistency reliability) for student-level scales ranged from 0.77 to 0.94. (See Appendix C for details.)

HLM Growth Analyses

Researchers used hierarchical linear modeling (HLM) growth models to examine the effects of Technology Immersion on students' individual growth rates for the six measures. For Cohort 2, we collected data at four time points: fall 2005 (baseline) and spring 2006, 2007, and 2008 (after students' first, second, and third immersion years, respectively). For Cohort 3, we collected data at three time points: fall 2006 (baseline) and spring 2007 and 2008 (after students' first and second immersion years). Analyses contrasted the growth trajectories for students at Technology Immersion and control schools. We analyzed immersion effects on students' self-perceptions and technology-related activities using three-level hierarchical linear growth models. These HLM models produced student- and school-specific effects (i.e., the extent to which scale scores varied across time, students, and schools).

Level 1: Repeated-Measures Model

Level 1 is a repeated-measures model (i.e., survey time within students) that enabled us to capture key features of growth (e.g., initial status, rate of change). In the model, Y_{tij} is the survey scale score at year t for student i in school j, and Survey Time is the point at which students completed surveys (Cohort 2, 0 = fall 2005, 1 = spring 2006, 2 = spring 2007, and 3 = spring 2008; Cohort 3, 0 = fall 2006, 1 = spring 2007, and 2 = spring 2008). The key parameters in the model are π_{0ij} and π_{1ij}. The coefficient π_{0ij} represents the "initial status" (that is, the estimated initial scale score), for student i in school j in fall, and π_{1ij} is the annual growth rate (rate of change) for student i in school j. The e_{tij} is the error term (within-student measurement error) assumed to be normally distributed with a mean of 0 and a constant variance. Thus, at Level 1, the model is

$$Y_{tij} = \pi_{0ij} + \pi_{1ij}\,(Survey\ Time)_{tij} + e_{tij.}$$

Level 2: Student-Level Model

The Level 2 model (between-students model) allowed us to determine differences between students in features of growth (e.g., initial status [π_{0ij}], rate of change [π_{1ij}]). In the student-level model, β_{00j} represents the mean initial status of a more advantaged student (advantaged = 0, disadvantaged = 1) within school j, and β_{10j} represents the mean rate of change for an advantaged student within school j. The coefficients β_{01j} and β_{11j} represent the effects of student poverty on initial status and school year rate of change, respectively. The r_{0ij} and r_{0ij} are residuals (i.e., random effects). At level 2, the model is

$$\pi_{0ij} = \beta_{00j} + \beta_{01j}(Disadvantaged)_{ij} + r_{0ij}$$
$$\pi_{1ij} = \beta_{10j} + \beta_{11j}(Disadvantaged)_{ij} + r_{1ij.}$$

Level 3: School-Level Model

At the school level (Level 3), we examined how students' initial status (β_{00j}) and growth (β_{10j}) varied across schools as a function of school-level random effects (μ_{00j} and μ_{10j}), as well as school conditions, including immersion status (an indicator variable with a value of 0 for a control school and a value of 1 for an immersion school) and school poverty (a continuous variable with percentages ranging from 31% to 100%, and with a grand mean of 68.5%). That is, we theorized that being in an immersion school was positively related to students' growth on technology-related scores, after controlling for the poverty level of the school. Thus, we posed the following school-level model:

$$\beta_{00j} = \gamma_{000} + \gamma_{001}(Immersion\ status)_j + \gamma_{002}(School\ Poverty)_j + \mu_{00j}$$
$$\beta_{10j} = \gamma_{100} + \gamma_{101}(Immersion\ status)_j + \gamma_{102}(School\ Poverty)_j + \mu_{10j.}$$

In the model, γ_{000} is the overall mean initial status of an advantaged student at a control campus with an average level of school poverty, and γ_{100} is the overall mean student growth rate (of an advantaged student at a control campus with an average level of school poverty). The coefficients γ_{001} and γ_{101} represent the direction and strength of association of immersion status on school-level initial status and growth rate, respectively. In addition, γ_{002} and γ_{102} represent the effect of school poverty on school-level initial status and growth rate, respectively. Analyses for Cohort 2 involved a total of 4,528 students who were continuously enrolled in schools since October 2005, with 2,167 at immersion schools and 2,361 at control schools. Analyses for Cohort 3 involved 4,445 students continuously enrolled since October 2006, with 2,073 at immersion schools and 2,372 at control schools.

Immersion Effects on Technology Experiences and Self-Perceptions

Analyses involved the estimation of three-level HLM growth models for Cohort 2 (six models) and Cohort 3 (five models). As Table 5.1 shows, we used separate models to estimate the effects of Technology Immersion on growth rates for measures of students' school technology experiences, including Classroom Activities, Small-Group Work, and Technical Problems, as well as students' self-perceptions of their Technology Proficiency, Self-Directed Learning (Cohort 2 only), and School Satisfaction.

Table 5.1. Cohorts 2 and 3: Immersion Effects on Estimated Mean Growth Rates for Student Mediating Variables

Scale Scores	Immersion Effect Net of Student and School Poverty[a]	Immersion Yearly Growth Rate		Control Yearly Growth Rate	
		Advantaged Students	Dis-advantaged Students	Advantaged Students	Dis-advantaged Students
Cohort 2 (8th Graders)					
School Technology					
Classroom Activities (5-pt)	Yes*	0.19	0.22	0.10	0.13
Small-Group Work (5-pt)	Yes**	0.10	0.10	0.01	0.01
Technical Problems (5-pt)	Yes***	0.34	0.36	0.15	0.16
Student Self-Perceptions					
Technology Proficiency (5-pt)	Yes**	0.35	0.35	0.26	0.26
Self-Directed Learning (7-pt)	No	-0.13	-0.13	-0.14	-0.14
School Satisfaction (5-pt)	No	-0.08	-0.05	-0.06	-0.03
Cohort 3 (7th Graders)					
School Technology					
Classroom Activities (5-pt)	Yes***	0.37	0.43	0.15	0.21
Small-Group Work (5-pt)	Yes**	0.11	0.14	-0.04	0.00
Technical Problems (5-pt)	Yes***	0.39	0.39	0.15	0.15
Student Self-Perceptions					
Technology Proficiency (5-pt)	Yes***	0.43	0.42	0.27	0.26
School Satisfaction (5-pt)	No	-0.07	-0.04	-0.09	-0.06

Source: Student surveys completed during the 2005-06, 2006-07, and 2007-08 school years.
Note. $^{\dagger}p < .10$. $*p < .05$. $**p < .01$. $***p < .001$. Items measured on either a 5-point or 7-point scale.
[a]For Cohort 3, Classroom Activities, the immersion effect is also net of initial status.

Summary results show that Technology Immersion had positive effects on students in a number of areas. After controls for school poverty (percentage of economically disadvantaged students) and student economic disadvantage (qualification for free- or reduced-price lunch), estimated mean yearly rates of change for advantaged and disadvantaged immersion students revealed statistically significant positive growth trends favoring immersion students for Classroom Activities, Small-Group Work, and Technology Proficiency. Growth rates also showed that immersion students, compared to control, reported more Technical Problems using computers, with the growth-rate difference between groups statistically significant for both seventh and eighth graders.

The Technology Immersion model also assumes that having daily access to and personal responsibility for laptop computers will allow immersion students to become more Self-Directed Learners and will increase their satisfaction with schoolwork (School Satisfaction). Contrary to expectations, as students in both the treatment and control groups advanced from sixth to higher grades, they reported being less self-directed learners and expressed less satisfaction with school. There were no statistically significant differences between the views of immersion and control-group students. Sections to follow provide additional details for the HLM analyses.

School Technology

Table 5.2 provides statistics for the HLM growth models estimating the immersion effects on Cohorts 2 and 3 students' technology experiences. Specific scales are discussed below.

Classroom Activities. Students reported the frequency with which their teachers had them use specific technology applications (e.g., use a word processor for writing, use a spreadsheet to calculate or graph, create a presentation) in their English language arts, mathematics, social studies, and science classes combined. Students reported their technology use on a 5-point scale ranging from 1 (*never*) to 5 (*almost daily*). As anticipated given the greater availability of hardware and software in immersion schools, treatment students had a significantly steeper growth rate for their frequency of technology use in core-subject classes.

Table 5.2. Cohorts 2 and 3: Immersion (Fixed) Effect Analyses of School Technology Variables

	Classroom Activities (with technology)		Small-Group Work		Technical Problems	
Dependent variable and predictor	Gamma Coefficient	*t*-value	Gamma Coefficient	*t*-value	Gamma Coefficient	*t*-value
Cohort 2 (8th Graders)						
Initial status (fall 2005)	2.058	39.61***	2.762	55.26***	2.209	50.50***
Immersion[a]	0.247	3.00**	-0.024	-0.34	-0.284	-4.32***
School Poverty	0.006	2.64*	0.002	1.28	0.005	2.31*
Economic Disadvantage	-0.005	-0.12	0.002	0.04	-0.058	-2.07*
Growth rate	0.099	3.41**	0.007	0.43	0.145	5.15***
Immersion	0.092	2.26*	0.091	3.12**	0.198	5.57***
School Poverty	-0.003	-2.35*	-0.001	-1.15	-0.002	-2.14*
Economic Disadvantage	0.029	1.88†	0.003	0.20	0.019	1.33
Cohort 3 (7th Graders)						
Initial status (fall 2006)	1.967	22.45***	2.785	41.57***	2.136	37.66***
Immersion[b,c]	0.436	3.67**	-0.015	-0.18	-0.139	-1.92†
School Poverty	0.004	1.13	0.002	0.79	-0.003	-1.67
Economic Disadvantage	0.002	0.03	-0.031	-0.58	-0.047	-1.11
Growth rate[b]	1.067	8.47***	-0.039	-1.17	0.152	4.12***
Immersion[b]	0.217	4.20***	0.144	3.09**	0.235	4.91***
School Poverty[b]	-0.003	0.044*	-0.001	-0.94	0.001	0.39
Economic Disadvantage	0.059	1.58	0.036	1.25	-0.001	-0.05
Initial status[b]	-0.464	-7.49***	--	--	--	--

†$p < .10$. *$p < .05$. **$p < .01$. ***$p < .001$.

[a]Cohort 2 immersion students initially had significantly higher classroom activities scores and significantly lower technical problem scores. Separate latent variable regressions controlling for the effects of initial differences indicated that, in both cases, immersion was a significant predictor of the growth rate with and without controlling for initial differences. Thus, the coefficients from original growth models are reported here.

[b]Cohort 3 immersion students initially had significantly higher classroom activities scores. A latent variable regression, controlling for the effects of the initial difference on the growth rate, revealed a significant immersion effect after controlling for initial differences. Thus, coefficients from the latent variable regression model are reported here.

[c]Cohort 3 immersion students initially had significantly lower technical problem scores. A latent variable regression, controlling for the effect of the initial difference on the growth rate, indicated that immersion was a significant predictor of growth with and without controlling for initial differences. Thus, the coefficients from the original growth model are reported here.

For Cohort 2 students, the yearly rates of change in Classroom Activities involving technology were 0.19 and 0.22 scale-score points for economically advantaged and disadvantaged immersion students, respectively. In contrast, advantaged and disadvantaged control students had flatter rates of change (0.10 and 0.13 scale-score points, respectively). For Cohort 3, the yearly rates of change in Classroom Activities for economically advantaged and disadvantaged immersion students were 0.37 and 0.43 scale-score points, respectively, whereas advantaged and disadvantaged control students had much flatter rates of changes (0.15 and 0.21 scale-score points, respectively). Figure 5.1 compares the mean growth trajectories for the frequency of Classroom Activities for Cohorts 2 and 3 student groups.

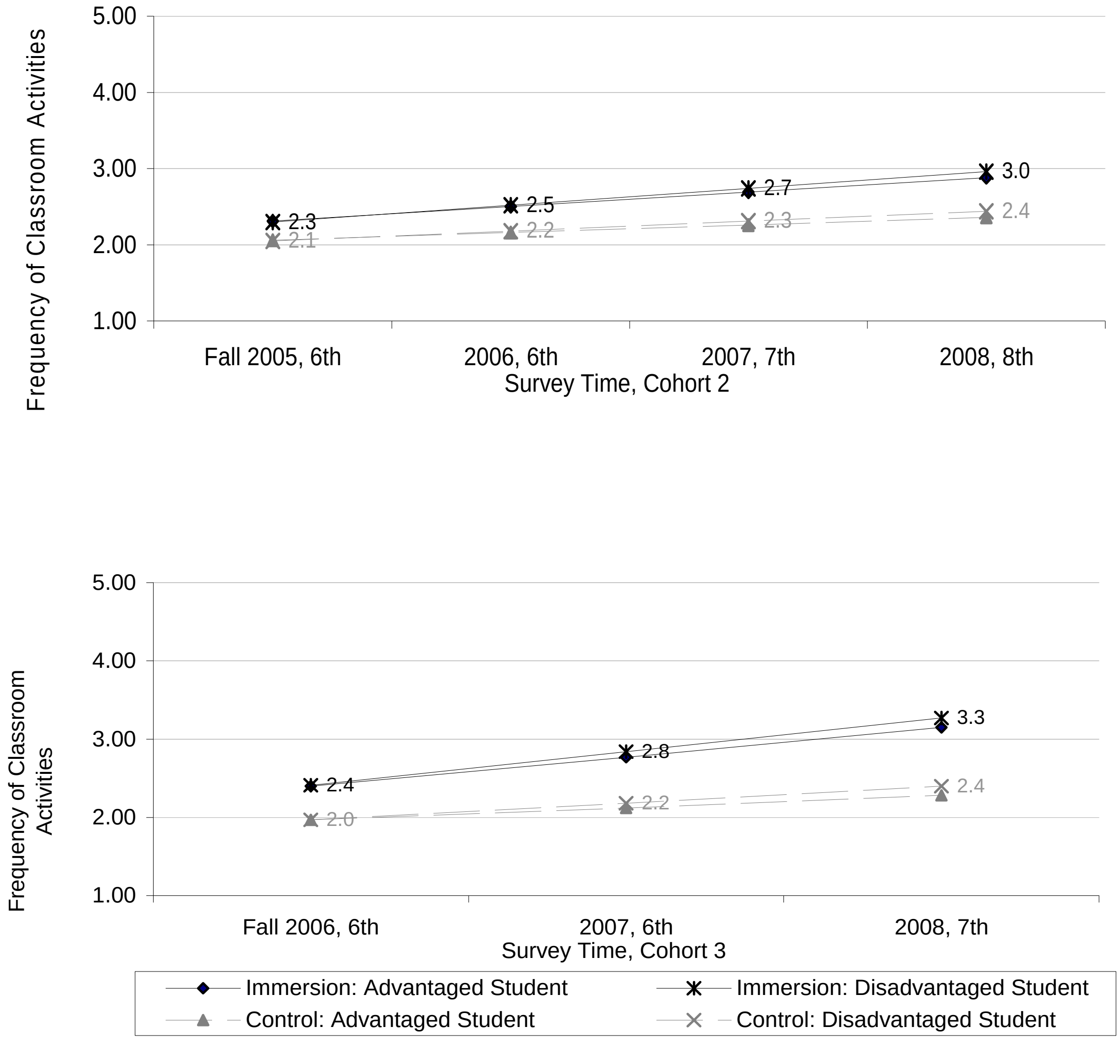


Figure 5.1. Estimated mean growth trajectories for the frequency of Classroom Activities for Cohorts 2 and 3 students, by economically advantaged and disadvantaged student groups in immersion and control schools. Estimated scale scores are displayed for disadvantaged students.

Cohort 2 economically advantaged and disadvantaged students in immersion schools had spring 2008 estimated Classroom Activities mean scores of 2.9 and 3.0, respectively, on the 5-point frequency scale, whereas mean scores for their control-group counterparts were 2.4 for both advantaged and disadvantaged students. Thus, despite significant increases in technology use by immersion students, mean use statistics indicated that students used various technology applications infrequently in classrooms (about *once or twice a month*). The growth trajectory for Cohort 3 immersion students was notably steeper, with students in spring 2008 using technology applications from *once or twice a month* to *once or twice a week* (M = 3.1 for advantaged and 3.3 for disadvantaged students). Across cohorts, students in control schools typically used technology applications just *a few times a year*.

Small-Group Work. We also asked students to rate the frequency of their small-group interactions with classmates. Students rated statements, such as "we tutor or coach each other," "brainstorm solutions to problems," and "discuss assignments" on a 5-point scale ranging from 1 (*never)* to 5 (*almost daily*). Growth rate coefficients showed that students in immersion schools reported increasing opportunities for small-group work with their peers. Across cohorts, economically advantaged and disadvantaged immersion students had significantly positive yearly growth rates (0.10 and 0.10 scale-score points, respectively, for Cohort 2; 0.11 and 0.14 scale-score points, respectively, for Cohort 3). Quite the opposite, students at control campuses reported stable or less frequent small-group activities across survey times (yearly growth rates for advantaged and disadvantaged students ranged from 0.01 to -0.04 scale-score points).

Technical Problems. Given the increased availability of technology in immersion schools and classrooms, we reasoned that students might encounter more technical problems. Thus, we asked students to indicate on a 5-point scale about how often various Technical Problems happened when they tried to use a computer at school. Across Cohorts 2 and 3, growth rates showed that immersion students reported more technical problems using computers compared to control students. Figure 5.2 shows that Cohort 2 immersion students initially reported fewer technical problems than control students, but by the end of eighth grade, both economically advantaged and disadvantaged immersion students reported more technical troubles. Still, mean scores in spring 2008 indicated that eighth graders, on average, rarely (a few times a year) or just sometimes (once or twice a month) had problems using computers at school.

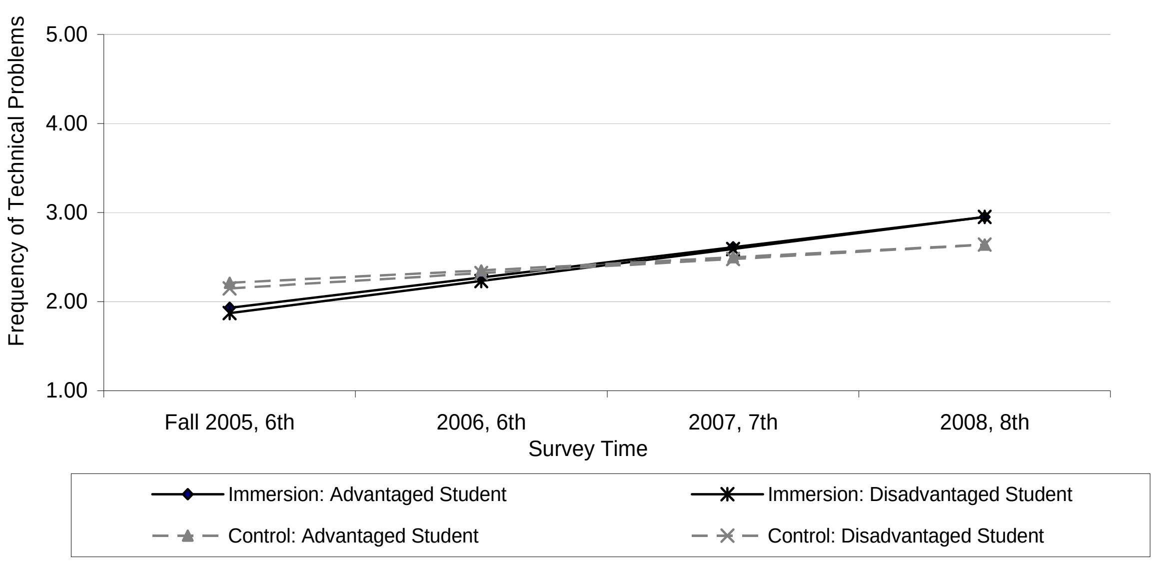


Figure 5.2. Estimated mean growth trajectories for the frequency of Technical Problems for Cohort 2 students, by economically advantaged and disadvantaged student groups in immersion and control schools.

Student Self-Perceptions

Table 5.3 provides statistical details for the HLM growth models gauging students' self-perceptions of their Technology Proficiency, Self-Directed Learning, and School Satisfaction. Individual scales are discussed below.

Table 5.3. Cohorts 2 and 3: Immersion (Fixed) Effect Analyses for Student Self-Perception Variables

	Technology Proficiency		Self-Directed Learning		School Satisfaction	
	Gamma Coefficient	*t*-value	Gamma Coefficient	*t*-value	Gamma Coefficient	*t*-value
Cohort 2 (8th Graders)						
Initial status (fall 2005)	2.982	54.45***	4.721	107.37***	3.829	130.76***
Immersion	-0.002	-0.02	-0.043	-0.78	0.038	1.03
School Poverty	0.002	0.93	0.003	1.58	0.000	-0.36
Economic Disadvantage	-0.264	-5.90***	-0.096	-3.64**	-0.140	-6.31***
Growth rate	0.256	11.34***	-0.142	-11.05***	-0.058	-4.90***
Immersion	0.094	3.06**	0.013	0.74	-0.018	-0.99
School Poverty	-0.001	-0.59	0.000	0.30	0.001	2.56*
Economic Disadvantage	0.004	0.25	0.002	0.21	0.029	2.71**
Cohort 3 (7th Graders)						
Initial status (fall 2006)	2.951	52.10***	--	--	3.797	138.60***
Immersion	-0.019	-0.22	--	--	0.050	1.33
School Poverty	0.001	0.45	--	--	-0.001	-1.05
Economic Disadvantage	-0.145	-3.38**	--	--	-0.084	-3.81***
Growth rate	0.266	13.75***	--	--	-0.092	-4.29***
Immersion	0.168	4.68***	--	--	0.022	0.69
School Poverty	-0.001	-1.37	--	--	0.001	0.95
Economic Disadvantage	-0.010	-0.57	--	--	0.035	1.74

$^{\dagger}p < .10$. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Technology Proficiency. As a measure of 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 statements aligned with the Texas Technology Applications Standards. Results for Cohorts 2 and 3 replicated results from previous project years. Both economically advantaged and disadvantaged immersion students grew in Technology Proficiency at a significantly faster rate than their counterparts in control schools. Specifically, for Cohort 2 students, the yearly rate of change in Technology Proficiency for both economically advantaged and disadvantaged immersion students was 0.35 scale-score points. In contrast, both advantaged and disadvantaged control students had somewhat flatter rates of change for Technology Proficiency (0.26 scale-score points). The yearly rates of change in Technology Proficiency for economically advantaged and disadvantaged Cohort 3 immersion students were 0.43 and 0.42 scale-score points, respectively, whereas advantaged and disadvantaged control students had slower rates of change (0.27 and 0.26 scale-score points, respectively).

Self-Directed Learning. Self-direction, as measured by the *SLI* for this study, includes statements relative to students' *forethought* (e.g., goal setting, strategic planning, self-efficacy beliefs, intrinsic effort), *performance/volition control* (e.g., attention focusing, self-monitoring, and help seeking), and *self-reflection* (e.g., self-evaluation, adaptivity). Although prior research suggested that the individualized learning opportunities allowed through one-to-one technology would positively affect students' self-regulated learning, our results, consistent with previous years, revealed no significant immersion effects on Cohort 2 students' growth in self-direction. As both immersion and control students progressed through eighth grade, their responses to statements revealed significantly negative growth trends. For Cohort 2, the estimated yearly rates of change in self-direction for both advantaged and disadvantaged students in immersion schools was -0.13 scale-score points, compared to -0.14 scale-score points, for their control-group counterparts. Overall findings indicated that students did not consider themselves to be strongly self-directed learners.

School Satisfaction. Students also rated their level of School Satisfaction by indicating the extent of their agreement with statements on a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). For example, students responded to items measuring their satisfaction with class work, the meaningfulness of class work, and the extent to which they perceived their class work to be useful to them in the future. As sixth graders, both immersion and control students generally *agreed* with statements measuring their school satisfaction. However, both treatment- and control-group students reported lower levels of school satisfaction across time. The estimated yearly rates of change in satisfaction for Cohorts 2 and 3 immersion students ranged from -0.04 to -0.08 scale-score points. Similarly, control students expressed declining levels of satisfaction with their schoolwork (-0.03 to -.09 scale-score points per year).

Immersion Effects on Student Engagement

Greater technology access and use, we theorized, would cause improvements in student conduct, and consequently, fewer discipline problems and increased school attendance. Findings presented below show positive effects of Technology Immersion on student discipline and behavior but not on school attendance.

Student Discipline and Behavior

As one indicator of engagement, we collected student-level data from schools on disciplinary actions occurring during the 2007-08 school year. Texas requires that schools report each disciplinary action that results in a removal of a student from their regular academic program for a full school day, so we compared the frequency of the disciplinary occurrences at treatment and control schools for Cohorts 2 and 3 students. The distributions of the disciplinary actions for students in each cohort were generally non-normal and negatively skewed. However, because of the robustness of *t*-tests of differences between mean scores to violations of the normality assumption (see Rasch & Guiard, 2004), this parametric procedure was used to examine differences between groups. Results show statistically significant differences between the frequency of student disciplinary actions at immersion and control schools, favoring immersion across two cohorts (Table 5.4). Figure 5.3 compares the average number of disciplinary actions for immersion and control schools for each student cohort.

Table 5.4. Differences between Mean Number of Disciplinary Actions per Student at Treatment and Control Schools by Cohort

	Immersion			Control				Cohen's
	N	Mean	*SD*	*N*	Mean	*SD*	*t*-value	*d*
Cohort 2 (8th Graders)	2,624	0.54	1.59	2,797	0.76	2.61	3.73***	-0.11
Cohort 3 (7th Graders)	2,590	0.45	1.44	2,825	0.71	2.33	5.00***	-0.13

***$p < .001$. *Note.* Independent samples *t*-test for differences between average disciplinary actions per student at treatment and control schools. *N* = number of students.

First, Cohort 2 eighth graders at immersion schools had significantly fewer disciplinary actions than control students ($t = 3.73$, $p < 0.001$). Specifically, 2,797 control-group students had an average of 0.76 disciplinary actions compared to 2,624 immersion students who had an average of 0.54 disciplinary events. Similarly, Cohort 3 seventh graders at immersion schools had significantly fewer disciplinary actions than students at control schools ($t = 5.00$, $p < 0.001$). In particular, 2,825 control-group students had an average of 0.71 disciplinary actions compared to 2,590 immersion students who had an average of 0.45 disciplinary actions. Effect sizes for the mean differences between groups were small across cohorts (-0.11 and -0.13, respectively).

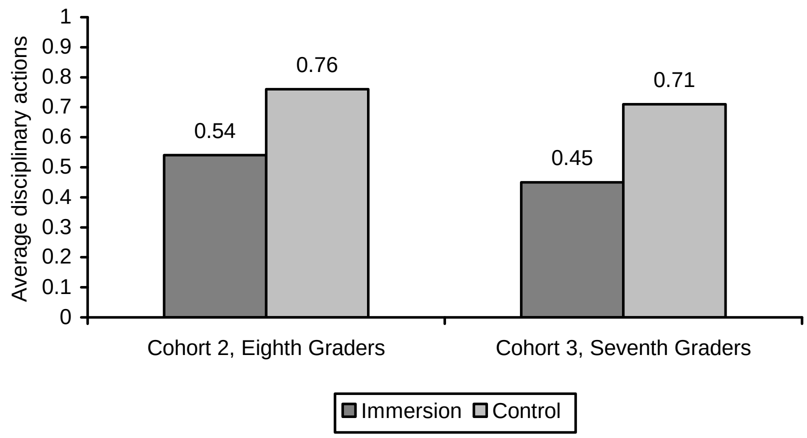


Figure 5.3. Average number of disciplinary actions per student for Cohorts 2 and 3.

Overall, fourth-year findings on student discipline and behavior mirror results for the first through third project years. Evidence shows that students attending Technology Immersion schools have fewer disciplinary referrals than their counterparts in control schools. Although the estimated size of differences between groups is considered statistically small, having fewer disciplinary actions per student in middle schools may have practically important benefits.

Student Attendance

School attendance rates (absolute values). Another indicator of engagement is students' school attendance. Accordingly, we compared the annual attendance rates for Cohort 2 students for the year before project implementation and for three implementation years, and Cohort 3 students for the year before implementation and for two implementation years (Table 5.5).

Table 5.5. School Attendance Rates for Cohorts 2 and 3 Students

	Immersion		Control		
	Mean	SD	Mean	SD	Difference
Cohort 2 (8th)					
2004-05	97.26	3.17	97.41	3.12	-0.15
2005-06	96.73	3.42	97.11	3.02	-0.38
2006-07	96.20	4.23	96.76	3.68	-0.56
2007-08	95.88	4.60	96.13	4.74	-0.25
Cohort 3 (7th)					
2005-06	97.02	3.34	97.28	3.08	-0.26
2006-07	96.30	4.14	96.93	3.63	-0.63
2007-08	96.08	4.20	96.34	4.17	-0.26

Results for Cohort 2 students show that the average attendance rate of immersion students was about 0.2 percentage point lower than the attendance rate of control students in the year before implementation, and the attendance-rate gap increased incrementally to about 0.6 percentage point lower after two implementation years. However, the gap decreased to about 0.3 percentage point lower after three years of implementation. In the same way, the average attendance rate of Cohort 3 immersion students was about 0.3 percentage point lower than the control group prior to project implementation, and after one year, the attendance rate of immersion students was 0.6 percentage point lower. However, after two years, the gap had decreased to 0.3 percentage point.

HLM analyses of attendance. To test the effects of immersion on student attendance, while controlling for school and student characteristics, we conducted HLM analyses. We used three-level HLM growth models to examine changes in school attendance rates over time. Table 5.6 presents the HLM statistics for each of the student cohorts. Results show that the effect of Technology Immersion on student attendance was negative but not by a statistically significant degree.

Table 5.6. Cohorts 2 and 3: Immersion (Fixed) Effect Analyses of Student Attendance

Group	School-Level Analysis	Gamma Coefficient	*t*
Cohort 2 (8th Graders)			
3-Level HLM Model	Initial attendance (2005)	97.587	677.01***
	Immersion	-0.232	-1.34
	School poverty	0.014	2.59*
	Disadvantaged	-0.356	-2.86**
	Growth rate	-0.189	-3.15***
	Immersion	-0.059	-0.86
	School poverty	0.001	0.40
	Disadvantaged	-0.288	-8.35***
Cohort 3 (7th Graders)			
3-Level HLM Model	Initial attendance (2006)	97.600	711.39***
	Immersion[a]	-0.476	-2.01*
	School poverty	0.022	4.12***
	Disadvantaged	-0.567	-4.31***
	Growth rate	-0.295	-3.15**
	Immersion[a]	-0.100	-0.85
	School poverty	-0.001	-0.32
	Disadvantaged	-0.115	-2.40*

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

[a]Immersed students in Cohort 3 had significantly lower initial 2006 attendance rates. A latent variable regression was run to control for the effect of this initial difference on the growth rate. The immersion effect was not a significant predictor of the growth rate with and without controlling for initial differences. Thus, the coefficients from the original growth model are reported here.

Average school attendance rates for economically advantaged Cohort 2 immersion and control-group students in schools with average rates of school poverty decreased as students advanced from fifth to eighth grade. The yearly estimated negative rate of change in attendance for immersion students (-0.25 percentage point) was greater than the annual change for control students (-0.19 percentage point). Thus, at the end of eighth grade, advantaged students in immersion schools had an estimated average attendance rate of 96.6% percent compared to 97.0% for control students (see Figure 5.4). Attendance rates for economically disadvantaged students decreased at a faster pace, with yearly negative change rates for disadvantaged students in immersion schools greater than the rates for control students (-0.54 percentage point versus -0.48 point, respectively). Thus, by the end of eighth grade, economically disadvantaged students in immersion schools had an attendance rate of 95.4% compared to 95.8% for control students. Similar results were found for Cohort 3 (Figure 5.5). While comparable trends were found across both cohorts, the differences in the growth rates were not statistically significant.

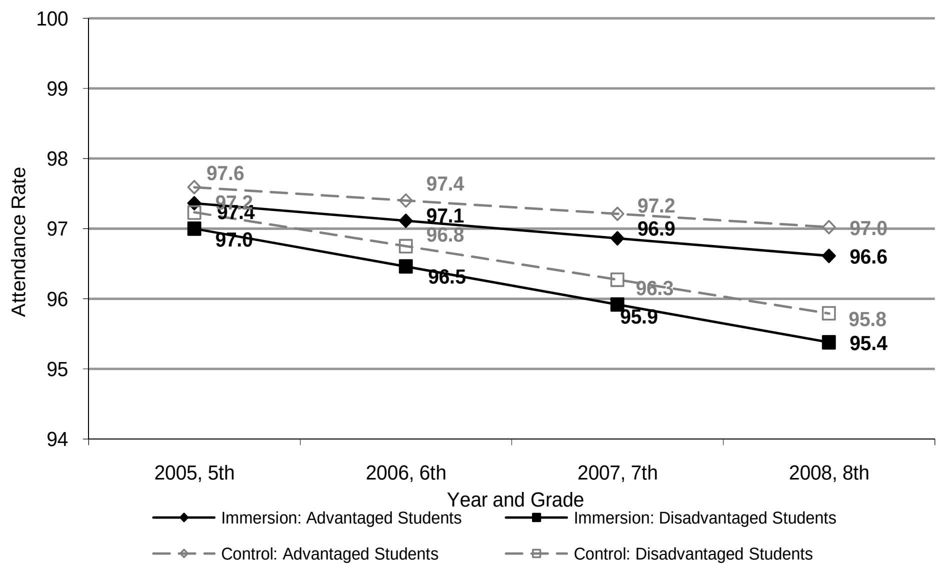


Figure 5.4. Estimated attendance rates for Cohort 2 economically advantaged and disadvantaged students in immersion and control schools with average rates of school poverty.

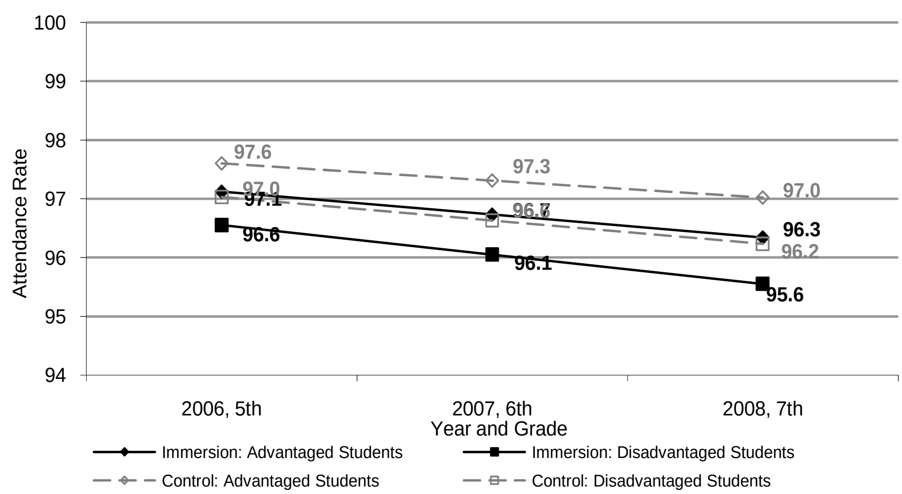


Figure 5.5. Estimated attendance rates for Cohort 3 economically advantaged and disadvantaged students in immersion and control schools with average rates of school poverty.

Conclusions

In the fourth project year, we investigated the effects of Technology Immersion on the learning experiences and competencies of students in Cohort 2 (eighth graders) and Cohort 3 (seventh graders). After controlling for important school and student characteristics, results across cohorts, consistent with previous evaluation years, confirmed the hypothesized positive effects of immersion on some mediating variables, but the outcomes for other variables were contrary to expectations. Key findings include the following.

- Across cohorts, Technology Immersion positively affected students' classroom technology use (Classroom Activities) and interactions with peers (Small-Group Work). Students in immersion schools used various technology applications significantly more often in their core-subject classrooms than control students. They also had significantly more frequent opportunities to learn in small groups with their classmates.
- Across cohorts, Technology Immersion positively affected students' Technology Proficiency, Cohorts 2 and 3 immersion students grew in proficiency at a significantly faster rate than control students. Moreover, Technology Immersion substantially narrowed the technology proficiency gap between economically advantaged and disadvantaged students. Economically disadvantaged immersion students had higher proficiency levels in spring 2008 than advantaged control students.
- Across cohorts, Technology Immersion students, compared to control-group students, reported significantly more Technical Problems using computers over time.
- Across cohorts, immersion and control-group students expressed similar levels of school satisfaction, with both groups reporting significantly lower levels of school satisfaction as they progressed to higher grade levels.
- Technology Immersion students in Cohort 2, who had access to personal laptop computers and resources for learning, regarded themselves as no more Self-Directed Learners than control students. As both immersion and control students progressed from sixth to eighth grade they reported less self-directed learning behaviors.
- Across cohorts, Technology Immersion positively affected student discipline and behavior. Students in immersion schools, on average, had proportionately fewer behavioral and disciplinary problems that removed them from the regular academic program than their counterparts in control schools.
- Contrary to expectations, results indicated that Technology Immersion had a negative but non-significant effect on students' school attendance. Across two cohorts, estimated attendance rates for immersion students were slightly lower than attendance rates for control-group students.

6. Effects of Technology Immersion on Student Achievement

The overarching goal of the Texas Technology Immersion project 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). We theorized that students who attended fully immersed schools would experience school and classroom conditions that promoted more individualized learning, more intellectually challenging work, and stronger engagement in school and learning. In turn, changes in students and their learning experiences would contribute to enhanced performance on state assessments.

In the fourth year of the project, as detailed in previous report chapters, we have noted teachers' substantial growth across years in the frequency and quality of classroom technology use, as well as improvements in students' technology proficiency and frequency of technology use. The following sections present academic achievement results for Cohort 2 students (eighth graders) and Cohort 3 students (seventh graders) who were enrolled continuously in the 21 Technology Immersion and 21 control schools through TAKS testing in April 2008. Additionally, we provide information on the progress of Cohort 1 students (ninth graders) who attended Technology Immersion and control schools from sixth through eighth grade and then were enrolled through 2008 TAKS testing in high schools that typically did not provide individual laptops for students. As far as we know, only one small high school provided one-to-one student access to laptops. Ninth graders at high schools, however, almost certainly continued to have access to computers in computer labs, in classrooms, or at home.

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 the middle school, TAKS assesses reading and mathematics at grades 6, 7, and 8, writing at grade 7, and science and social studies at grade 8. The TAKS also assesses reading and mathematics at grade 9. This study uses several types of TAKS scores.

- **Met the standard.** This score represents satisfactory academic achievement. Students who met 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 met 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 the 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. TAKS scale scores are used to calculate standardized scores for this study.

Texas has phased-in increasingly rigorous passing standards on the TAKS. In 2004-05, passing standards recommended for reading, mathematics, writing, social studies, and grade 5 science by the State Board of Education panel were fully implemented. For the newer grade 8 science test, the panel-recommended standard had to be met in 2007-08. For this study, all TAKS scores reported are based on panel-recommended standards.

Standard Scores

In addition to the scores provided by the Texas Education Agency (TEA), researchers generated standard scores that were used to compare student progress on TAKS across grade levels. A standardized score—or *z* score—was 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, indicates how many standard deviations from the mean a score lies. One characteristic of *z* scores is that about half of the scores are negative, and negative scores may be difficult to fully understand. To overcome this limitation, we have transformed students' *z* scores into normalized scores, or *T* scores. *T* scores are scores with a mean of 50 and a standard deviation of 10. Thus, a student who scores at the state average will have a TAKS *T* score of 50. A student who has a score of 60 will be one standard deviation above the state average, and a student who has a score of 40 will be one standard deviation below the state average.

Progress in Meeting TAKS Standards

TAKS Reading

Students' progress in meeting TAKS passing and commended performance standards is one measure of student academic outcomes. Information in Table 6.1 compares the absolute performance of students in immersion and control schools for TAKS reading (Cohorts 2 and 3) and also compares the reading performance of post-immersion and control ninth graders (Cohort 1).

Table 6.1. TAKS Passing and Commended Performance Rates for Reading

Cohort	Group	N	2004 Percent	2005 Percent	2006 Percent	2007 Percent	2008 Percent	*Baseline to 2008 Difference*
Met Standard								
Cohort 1	Post-immersion	1,332	*68.5*	77.0	73.8	86.9	87.8	**19.3**
Grade 5 to 9	Control	1,552	*74.5*	83.0	79.1	88.7	90.2	15.7
Cohort 2	Immersion	1,434	--	*68.1*	88.6	82.3	93.5	**25.4**
Grade 5 to 8	Control	1,569	--	*74.7*	91.7	85.0	95.4	20.7
Cohort 3	Immersion	1,548	--	--	*74.4*	87.5	83.5	**9.1**
Grade 5 to 7	Control	1,771	--	--	*81.0*	92.4	86.9	5.9
Commended Performance								
Cohort 1	Post-immersion	1,332	*19.9*	29.3	17.1	35.5	32.1	**12.2**
Grade 5 to 9	Control	1,552	*23.5*	35.7	18.9	41.0	33.6	10.1
Cohort 2	Immersion	1,434	--	*18.1*	30.5	22.0	48.5	30.4
Grade 5 to 8	Control	1,569	--	*19.4*	34.6	21.0	50.0	**30.6**
Cohort 3	Immersion	1,548	--	--	*19.1*	40.8	26.6	**7.5**
Grade 5 to 7	Control	1,771	--	--	*21.1*	47.7	27.6	6.5

Source: Analysis of individual student data from TEA.
Note. Cohorts 2 and 3 include students in 21 treatment and 21 control schools that had TAKS scores and attended the same school across years. Cohort 1 (post-immersion) includes treatment and control students that attended various high schools as ninth graders during the fourth year. Italic numbers denote baseline scores. Bold numbers denote superior baseline-to-2008 differences.

Results show that Cohorts 2 and 3 students at Technology Immersion schools had slightly lower passing rates in spring 2008 for TAKS reading than students at control campuses. However, students at immersion campuses had greater baseline-to-2008 passing increases. For Cohort 2, TAKS-score comparisons between 2005 (5th grade baseline) and 2008 (8th grade) revealed larger reading gains for the immersion group (25.4 percentage points versus 20.7 points for the control group). Similarly, for Cohort 3, the TAKS passing rate difference between 2006 (5th grade baseline) and 2008 (7th grade) favored students at immersion schools (9.1 percentage points versus 5.9 points for control students). Similarly, for Cohort 1 students who left treatment and control schools and enrolled in high schools, TAKS-score comparisons between 2004 (5th grade baseline) and 2008 (9th grade) revealed larger reading gains for the immersion group (19.3 percentage points versus 15.7 points for the control group).

For commended performance, Cohorts 1, 2, and 3 students at control schools had slightly higher 2008 achievement rates. Cohorts 1 and 3 students at immersion schools had slightly larger baseline-to-2008 gains, whereas Cohort 2 students at immersion and control schools had nearly identical gains.

TAKS Mathematics

Results for TAKS mathematics show that Cohort 2 students at immersion schools had higher mathematics passing rates in spring 2008 than students at control campuses. They also had considerably larger baseline-to-2008 gains (4.8 percentage points versus -5.9 percentage points). Cohort 3 students in immersion schools and Cohort 1 post-immersion ninth graders had slightly lower TAKS mathematics passing rates in 2008 than students at control campuses; however, TAKS-score comparisons across years revealed smaller TAKS mathematics passing-rate decreases for the immersion and post-immersion students (Table 6.2).

Table 6.2. TAKS Passing and Commended Performance Rates for Mathematics

Cohort	Group	N	2004 Percent	2005 Percent	2006 Percent	2007 Percent	2008 Percent	*Baseline to 2008 Difference*
Met Standard								
Cohort 1	Post-immersion	1,345	*70.9*	62.9	66.3	71.4	66.8	**-4.1**
Grade 5 to 9	Control	1,560	*73.5*	68.2	68.6	71.7	67.1	-6.4
Cohort 2	Immersion	1,435	--	*74.4*	73.7	74.1	79.2	**4.8**
Grade 5 to 8	Control	1,576	--	*80.3*	76.0	75.0	74.4	-5.9
Cohort 3	Immersion	1,555	--	--	*79.3*	74.9	75.2	**-4.1**
Grade 5 to 7	Control	1,809	--	--	*85.0*	79.0	77.4	-7.6
Commended Performance								
Cohort 1	Post-immersion	1,345	*24.3*	19.6	11.2	15.8	20.5	**-3.8**
Grade 5 to 9	Control	1,560	*24.8*	22.0	9.7	13.8	20.9	-3.9
Cohort 2	Immersion	1,435	--	*23.6*	23.6	16.9	21.1	**-2.5**
Grade 5 to 8	Control	1,576	--	*25.9*	23.6	12.7	16.0	-9.9
Cohort 3	Immersion	1,555	--	--	*32.9*	29.5	16.8	**-16.1**
Grade 5 to 7	Control	1,809	--	--	*37.7*	28.2	15.6	-22.1

Source: Analysis of individual student data from TEA.
Note. Cohorts 2 and 3 include students in 21 treatment and 21 control schools that had TAKS scores and attended the same school across years. Cohort 1 (post-immersion) includes treatment and control students that attended various high schools as ninth graders during the fourth year. Italic numbers denote baseline scores. Bold numbers denote superior baseline-to-2008 differences.

Overall, students had greater difficulty meeting commended standards for mathematics compared to reading. For Cohorts 2 and 3, students at immersion schools had slightly higher 2008 commended performance rates, and immersion students had smaller baseline-to-2008 rate declines (-2.5 percentage points versus -9.9 points for Cohort 2; -16.1 percentage points versus -22.1 points for Cohort 3). For Cohort 1, post-immersion and control ninth graders had nearly identical 2008 commended performance rates and declines over time.

TAKS Social Studies, Science, and Writing

The TAKS reading and mathematics tests are administered annually, whereas TAKS tests are administered periodically in other subject areas. In the fourth year, Cohort 2 eighth graders completed TAKS social studies and science assessments, while Cohort 3 seventh graders completed TAKS writing. Baseline measures were available for TAKS science in grade 5 and writing in grade 4. There was no pre-measure for TAKS social studies.

Results for TAKS social studies in Table 6.3 show that Cohort 2 eighth graders at control schools had slightly higher TAKS passing rates and commended performance rates for social studies in 2008 (89.1% versus 88.6%; 31.6% versus 29.9%). Cohort 2 students at immersion schools had lower TAKS passing rates for science in 2008 (61.4%) than control students (67.3%) but nearly identical baseline to 2008 passing rate increases (5.0 and 4.9 percentage points, respectively). Similarly, Cohort 2 immersion students had lower TAKS commended performance rates for science in 2008 (15.7%) than control students (18.0%) but nearly identical baseline-to-2008 passing rate decreases (-5.9 and -5.7 percentage points, respectively).

Table 6.3. Cohort 2 (Eighth Graders in 2007-08):
TAKS Passing and Commended Performance Rates for Social Studies and Science

TAKS Test	Group	N	2005 Grade 5 Percent	2008 Grade 8 Percent	*Baseline to 2008 Difference*
Met Standard					
Social Studies	Immersion	1,546	--	88.6	--
	Control	1,663	--	89.1	--
Science	Immersion	1,430	*56.4*	61.4	**5.0**
	Control	1,550	*62.4*	67.3	4.9
Commended Performance					
Social Studies	Immersion	1,546	--	29.9	--
	Control	1,663	--	31.6	--
Science	Immersion	1,430	*21.6*	15.7	-5.9
	Control	1,550	*23.7*	18.0	**-5.7**

Source: Analysis of individual student data from TEA.
Notes. Students had TAKS scores and attended the same school across years. Italic numbers denote baseline scores. Bold numbers denote superior baseline-to-2008 differences.

Table 6.4 shows that Cohort 3 students at immersion and control schools had similar TAKS passing rates for writing in 2008, but immersion students' TAKS-score gains between 2005 (4th grade baseline) and 2008 (7th grade) were larger. However, control students achieved commended performance in writing at a higher rate and had larger gains than immersion students (14.0 percentage points versus 11.8 points).

Table 6.4. Cohort 3 (Seventh Graders in 2007-08): TAKS Passing and Commended Performance Rates for Writing

TAKS Test	Group	N	2005 Grade 4 Percent	2008 Grade 7 Percent	*Baseline to 2008 Difference*
Met Standard					
Writing	Immersion	1,435	*89.0*	93.9	**4.9**
	Control	1,641	*92.8*	94.1	1.3
Commended Performance					
Writing	Immersion	1,435	*19.0*	30.8	11.8
	Control	1,641	*21.4*	35.4	**14.0**

Source: Analysis of individual student data from TEA.
Notes. Students had TAKS scores and attended the same school across years. Italic numbers denote baseline scores. Bold numbers denote superior baseline-to-2008 difference.

Altogether, TAKS passing rates provide important evidence that helps to understand student progress toward meeting state standards—however, additional statistical analyses are necessary to assess the effects of immersion on student achievement.

Effects of Immersion on Academic Achievement

Researchers used hierarchical linear modeling (HLM) to estimate the effects of immersion on students' academic achievement. HLM is a "value added" methodology. That is, after controlling for students' initial achievement and characteristics and accounting for variance at the student and school levels, researchers can assess the "value added" by the treatment. The analyses to follow contrast the achievement of three student cohorts:

- Cohort 2, before and after three immersion years (sixth to eighth grade),
- Cohort 3, before and after two immersion years (sixth to seventh grade), and
- Cohort 1, before and after three immersion years and one post-immersion year (sixth to ninth grade).

Immersion effects for Cohort 2 are estimated for TAKS reading, mathematics, social studies, and science *T* scores. For Cohort 3, effects are estimated for TAKS reading, mathematics, and writing *T* scores. The enduring effects of attending an immersion school are estimated for Cohort 1 students for TAKS reading and mathematics *T* scores. We used three-level HLM growth models to examine changes in students' TAKS reading and mathematics achievement over time. For TAKS social studies, science, and writing, students had scores for only two time points, so data analysis involved two-level HLM models. (See Appendix E for technical detail on the HLM models.)

The availability of longitudinal achievement data for three student cohorts allowed researchers to evaluate program effects by examining the importance of group differences, and the replicability or truth of group differences across cohorts and outcome measures (e.g., Cohen, 1994; Schmidt, 1996). Since small effects are noteworthy when evidence indicates that effects are replicable, we have reported effects as statistically significant at less conservative levels ($p < .10$) when findings provided evidence of important trends.

TAKS Reading

Cohorts 2 and 3 (Technology Immersion)

TAKS reading achievement growth trajectories were estimated for Cohorts 2 and 3 students in immersion and control schools. Three-level HLM growth models examined the extent to which student achievement varied across time, students, and schools. Given the complexity of interpreting growth models, we constrained our final models to include school and student predictors that exhibited strong associations with achievement (i.e., school and student poverty). In the HLM growth model, Level 1 is a repeated-measures model (i.e., TAKS assessment time within students) that captures the key features of growth (e.g., initial status, rate of change). Time is the point at which students completed assessments each spring (Cohort 2, 0 = 2005, 1 = 2006, 2 = 2007, 3 = 2008; Cohort 2, 0 = 2006, 1 = 2007, 2 = 2008).

The between-students model (Level 2) modeled differences between students in features of growth (e.g., initial status, rate of change), after adjusting for students' economic status (1 if economically disadvantaged [i.e., eligible for the federal free- and reduced-price lunch program], 0 if not). At the school level (Level 3), we examined how students' initial status and growth varied across schools as a function of school-level random effects, as well as school conditions, including group membership (1 for immersion, 0 for the control group) and school poverty (percentage of economically disadvantaged students attending a school). School poverty rates ranged from 31% to 100%, with a mean of 68.5%. Thus, we hypothesized that being in an immersion school was positively related to students' growth in achievement, after controlling for the poverty level of the school.

Separate HLM growth models were used to determine the effects of immersion on Cohort 2 and Cohort 3 students' growth in TAKS reading achievement (Table 6.5). Growth models estimated school mean rates of change for immersion and control students, as well as the separate effects of student economic disadvantage and the school poverty concentration on reading. Analyses for Cohort 2 involved 1,571 immersion and 1,697 control students. Comparison groups had nearly equivalent proportions of students included in longitudinal analyses (60.9% for immersion and 59.4% for control). Cohort 3 analyses involved 1,690 immersion and 1,965 control students. As with Cohort 1, analyses involved nearly equal proportions of students across groups (66.4% for immersion and 69.1% for control).

Table 6.5. HLM Statistics for Cohort 2 and Cohort 3 Students: Effects of Immersion on TAKS Reading Achievement Growth Rates

Dependent variable and predictor	Cohort 2 (Eighth Graders) N = 3,268		Cohort 3 (Seventh Graders) N = 3,655	
	Gamma Coefficient	*t*-value	Gamma Coefficient	*t*-value
Initial mean status (2005/2006 TAKS *T* score)	52.427	102.75***	52.775	99.01***
Immersion	-0.315	-0.54	-0.751	-1.31
School poverty	-0.091	-6.69***	-0.083	-4.78***
Economic disadvantage	-5.664	-9.50***	-5.123	-6.83***
Growth rate	0.131	1.08	-0.104	-0.53
Immersion	0.234	1.55	0.105	0.58
School poverty	0.010	1.95†	0.015	2.38*
Economic disadvantage	0.308	2.95**	0.109	0.64

†p < .10. *p < .05. **p < .01. ***p < .001.

As Table 6.5 shows, the initial mean TAKS reading status for the Cohort 2 reference group (an economically advantaged eighth grader in a control school with an average level of school poverty) is estimated at 52.43 (the mean 2005 TAKS reading *T* score). The coefficient representing immersion (-0.315) shows that students in immersion schools had lower initial TAKS reading *T* scores (52.11) than control students. Considering that differences among schools in students' initial achievement may be related to subsequent rates of change, we used statistical tests to establish that those differences did not affect the estimations of student growth. Coefficients for initial status also showed that economically disadvantaged students and students attending schools with above average levels of poverty started behind their more advantaged counterparts in reading ability (-5.66 and -0.09 *T*-score points, respectively).

After controlling for prior achievement and student and school levels of poverty, results show there was no statistically significant effect of immersion on Cohort 2 students' growth rate for TAKS reading. Reading achievement for advantaged students in control schools (with average poverty) increased by 0.13 *T*-score point per year. The coefficient for immersion (0.234) indicates that reading scores for advantaged students in immersion schools (with average poverty) increased at a slightly faster rate (0.37 *T*-score point per year) compared to control-group students (0.131 + 0.234 = 0.365). Economically disadvantaged eighth graders at both immersion and control schools grew in reading achievement at significantly faster rates than their more advantaged peers (0.67 *T*-score point per year for immersion and 0.44 *T*-score point for control students). Figure 6.1 illustrates the estimated mean TAKS reading growth trajectories for advantaged and disadvantaged Cohort 2 students by school comparison group.

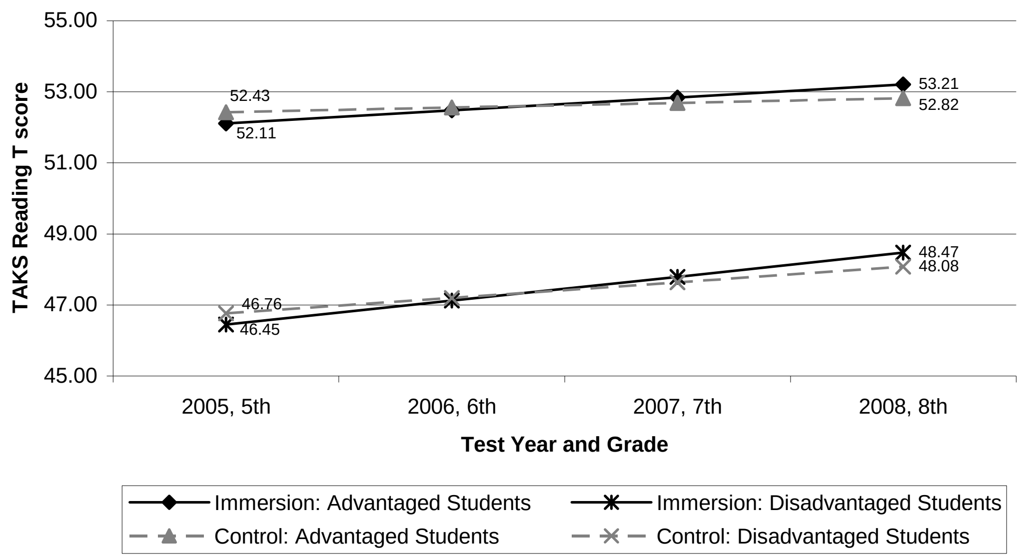


Figure 6.1. Estimated mean TAKS reading achievement growth trajectories for Cohort 2 economically advantaged and disadvantaged student groups in immersion and control schools. Growth rate difference between the immersion and control groups is statistically insignificant.

TAKS reading outcomes for Cohort 3 students, similarly, showed no statistically significant effect of immersion on seventh graders' reading achievement. The estimated reading *T* scores of advantaged seventh graders in control schools with average poverty decreased (-0.10 *T*-score point per year), while the scores for advantaged students in immersion schools remained stable (0.00 *T*-score point per year). Economically disadvantaged seventh graders at both immersion and control schools grew in reading at a slightly faster rate than their more advantaged counterparts.

Across both Cohorts 2 and 3, the extent of school poverty was a statistically significant positive predictor of students TAKS reading growth rate. With each percentage point increase in school poverty, Cohorts 2 and 3 students' reading *T* score increased by 0.01 and 0.02 *T*-score point per year, respectively.

Cohort 1 (Post-Immersion)

We also estimated the continuing effect of attending an immersion school on Cohort 1 students' TAKS reading *T* scores using an HLM growth model (Table 6.6). In the three-level HLM model, level 1 is a repeated-measures model (i.e., TAKS assessment time within students) that captures the key features of growth. Time is the point at which students completed assessments each spring (0 = 2004, 1 = 2005, 2 = 2006, 3 = 2007, 4 = 2008-post immersion). Level 2 (between-students model) modeled features of growth after adjusting for students economic status. At Level 3 (school level), we examined how students' initial status and growth varied across schools as a function of school-level random effects, as well as school conditions, including group membership (1 for post-immersion, 0 for the control group) and school poverty. School poverty was a continuous variable depicting the concentration of economically disadvantaged students in the students' feeder middle schools. Analyses involved 1,506 post immersion students and 1,805 control students, with similar proportions of students included in analyses (61.0% and 65.7%, respectively).

Table 6.6. HLM Statistics for Cohort 1 Students: Enduring Effects of Immersion on TAKS Reading Achievement Growth Rates

Dependent variable and predictor	TAKS Reading $N = 3{,}311$ Gamma Coefficient	*t*-value
Initial mean status (2004 TAKS *T* score)	53.283	81.430***
Immersion	-1.205	-1.650
School poverty	-0.072	-4.451***
Economic disadvantage	-6.271	-10.707***
Growth rate	-0.014	-0.158
Immersion	0.203	1.932†
School poverty	0.008	2.902**
Economic disadvantage	0.367	4.371***

$^{\dagger}p < .10$. $*p < .05$. $**p < .01$. $***p < .001$.
Note. Cohort 1 includes treatment and control students that attended various high schools as ninth graders in the fourth year.

TAKS reading outcomes for ninth graders reported in Table 6.6 show that after controlling for students' prior reading achievement, the level of middle-school poverty, and students' economic disadvantage, there was a statistically significant positive sustaining effect of immersion ($p < .06$) on the TAKS reading *T* scores of students who had attended immersion middle schools and then moved on to mainly traditional high schools. Reading achievement for advantaged control students (with average school poverty) decreased by 0.01 *T*-score point per year, whereas the reading achievement of advantaged post-immersion students increased by 0.19 *T*-score point per year. Economically disadvantaged students grew in reading achievement at significantly faster rates than their advantaged peers. Given the positive treatment-group boost, disadvantaged post-immersion students grew at a notably faster rate than their control-group counterparts (0.56 *T*-score point per year versus 0.35 point). Figure 6.2 illustrates how the more positive TAKS reading growth trajectories of post-immersion students has narrowed the initial reading achievement gap between the treatment and control groups.

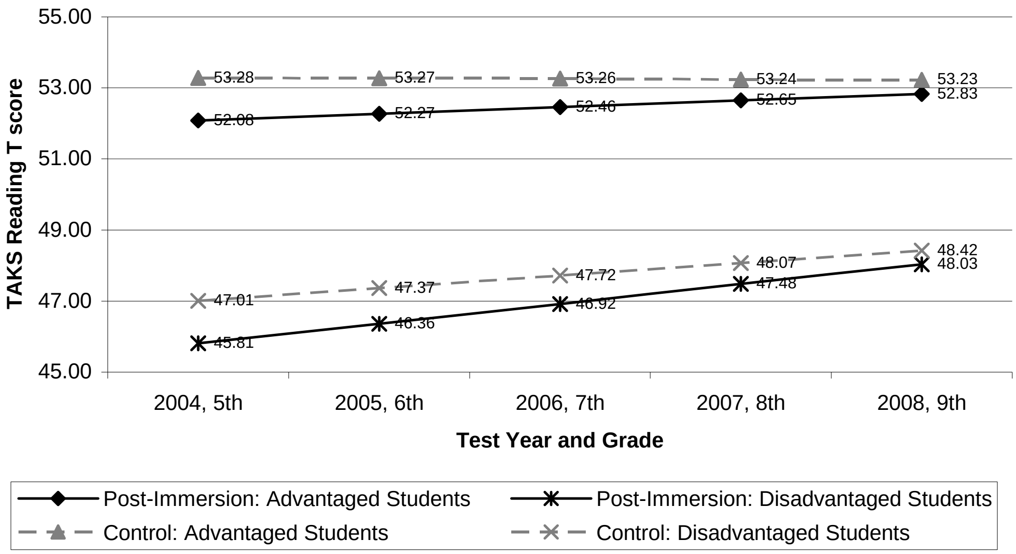


Figure 6.2. Estimated mean TAKS reading achievement growth trajectories for Cohort 1 economically advantaged and disadvantaged post-immersion and control students. The growth rate difference between post-immersion and control groups is statistically significant (p < .10).

TAKS Mathematics

Cohorts 2 and 3 (Technology Immersion)

Similar to reading, we estimated the TAKS mathematics achievement growth trajectories for Cohorts 2 and 3 students in immersion and control schools (Table 6.7). Three-level HLM growth models were used to examine the extent to which mathematics achievement varied across time (the point at which students completed TAKS assessments each spring), students, and schools.

Table 6.7. HLM Statistics for Cohort 2 and Cohort 3 Students: Effects of Immersion on TAKS Mathematics Achievement Growth Rates

Dependent variable and predictor	Cohort 2 (Eighth Graders) N = 3,268		Cohort 3 (Seventh Graders) N = 3,655	
	Gamma Coefficient	t-value	Gamma Coefficient	t-value
Initial mean status (2004/2005 TAKS T score)	52.152	91.21***	52.557	79.46***
Immersion	-0.891	-1.37	-1.465	-2.19*
School poverty	-0.052	-2.70*	-0.040	-2.10*
Economic disadvantage	-4.623	-7.78***	-3.893	-5.90***
Growth rate	-0.230	-1.20	-0.417	-1.93†
Immersion	0.653	2.58*	0.787	2.69*
School poverty	0.005	0.70	0.025	3.05**
Economic disadvantage	0.179	1.61	-0.325	-1.64

†p < .10. *p < .05. **p < .01. ***p < .001.

Results for Cohort 2 students show that control students initially had an estimated mean mathematics T score of 52.15, whereas immersion students began with a lower estimated mathematics score

(51.25). Economically disadvantaged students and students attending schools with above average levels of poverty started significantly behind their more advantaged peers in math ability (-4.62 *T*-score points and -0.05 point, respectively). After controlling for student and school levels of poverty, Technology Immersion had a positive and statistically significant effect on students' growth rate for TAKS mathematics ($p < .05$). Estimated mathematics achievement for economically advantaged students in immersion schools (with average poverty) increased by about 0.42 *T*-score point per year (coefficient of 0.653), while the math scores of their control-group counterparts decreased by about 0.23 *T*-score point per year (coefficient of -0.230). Economically disadvantaged students in immersion schools grew in mathematics achievement at an even faster rate (about 0.60 *T*-score point per year) that well out-paced economically disadvantaged control students (-0.05 point per year). Figure 6.3 illustrates the estimated mean TAKS mathematics growth trajectories for Cohort 2 advantaged and disadvantaged students at immersion and control schools.

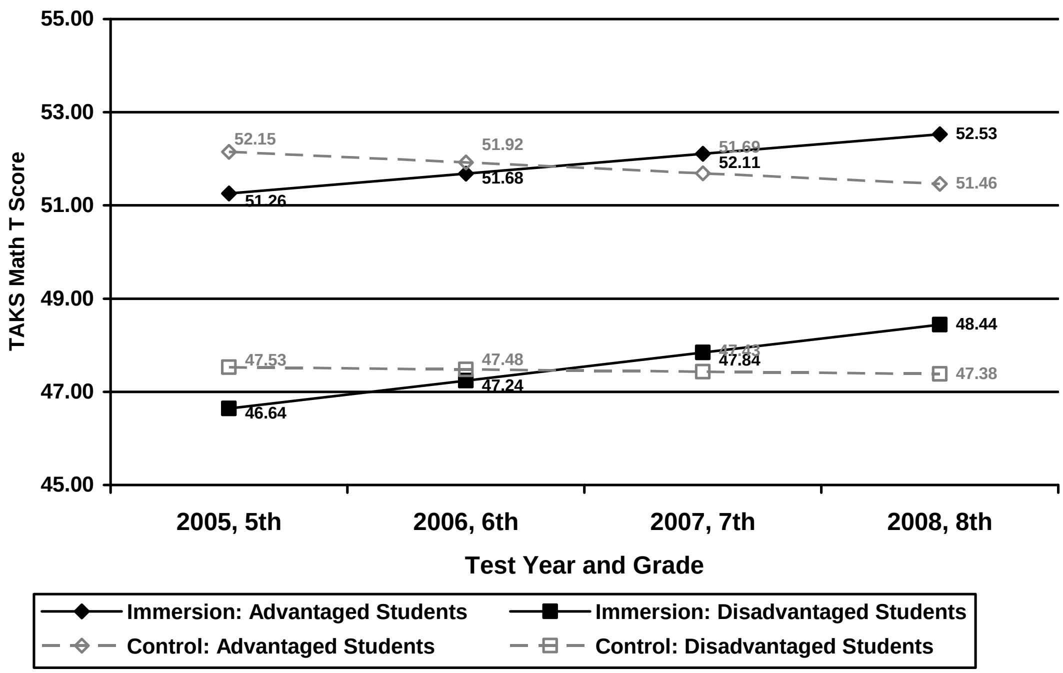


Figure 6.3. Estimated mean TAKS mathematics achievement growth trajectories for Cohort 2 economically advantaged and disadvantaged immersion and control students. The growth rate difference between the immersion and control groups is statistically significant ($p < .05$).

Similarly, TAKS mathematics outcomes for Cohort 3 revealed a statistically significant positive effect of immersion on seventh graders' math achievement for both advantaged and disadvantaged students ($p < .05$). The mathematics *T* scores of advantaged seventh graders in immersion schools (with average poverty) increased (0.37 *T*-score point per year), while the scores for advantaged students in control schools decreased (-0.42 *T*-score point per year). Similarly, the math scores for economically disadvantaged seventh graders at immersion schools increased (0.05 *T*-score point per year), whereas disadvantaged control-group students had a negative growth trend (-0.74 *T*-score point per year). Figure 6.4 illustrates the estimated mean TAKS mathematics growth trajectories for Cohort 2 advantaged and disadvantaged students at immersion and control schools.

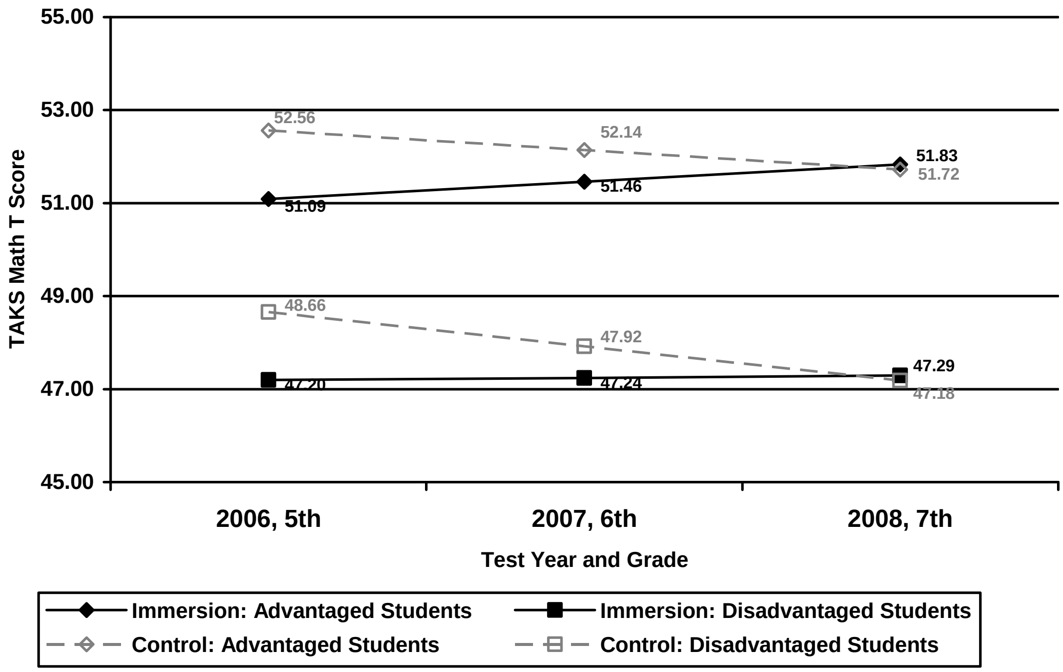


Figure 6.4. Estimated mean TAKS mathematics achievement growth trajectories for Cohort 3 economically advantaged and disadvantaged immersion and control students. The growth rate difference between the immersion and control groups is statistically significant ($p < .05$).

Cohort 1 (Post-Immersion)

We also examined the enduring effect of attending an immersion school on Cohort 1 students' TAKS mathematics *T* scores. Like reading, we used a three-level HLM growth model to estimate the TAKS mathematics growth trajectories for Cohort 1 post-immersion and control students (Table 6.8). Analyses involved 1,506 post-immersion ninth graders and 1,805 control ninth graders, with similar proportions of students included in analyses (61.0% and 65.7%, respectively).

Table 6.8. HLM Statistics for Cohort 1 Students: Enduring Effects of Immersion on TAKS Mathematics Achievement Growth Rates

Dependent variable and predictor	TAKS Mathematics $N = 3{,}311$	
	Gamma Coefficient	*t*-value
Initial mean status (2004 TAKS *T* score)	52.372	71.820***
Immersion	-1.122	-1.270
School poverty	-0.046	-2.307*
Economic disadvantage	-4.523	-9.029***
Growth rate	0.221	1.726†
Immersion	0.313	1.602
School poverty	0.008	1.398
Economic disadvantage	-0.126	-1.073

†$p < .10$. *$p < .05$. **$p < .01$. ***$p < .001$.
Note. Cohort 1 includes treatment and control students that attended various high schools as ninth graders in the fourth year.

TAKS mathematics outcomes for Cohort 1 revealed that after controlling for student and school levels of poverty, there was no statistically significant effect of immersion on ninth graders' growth rate for TAKS mathematics. The immersion effect was positive but not by a significant margin. The mathematics *T*-scores of advantaged post-immersion students increased by about 0.53 *T*-score point per year compared to 0.22 *T*-score point for control-group students. Economically disadvantaged post-immersion ninth graders grew in mathematics achievement at a faster rate (0.41 *T*-score point per year) than advantaged control students (0.22 point per year) and disadvantaged control students (0.10 point per year).

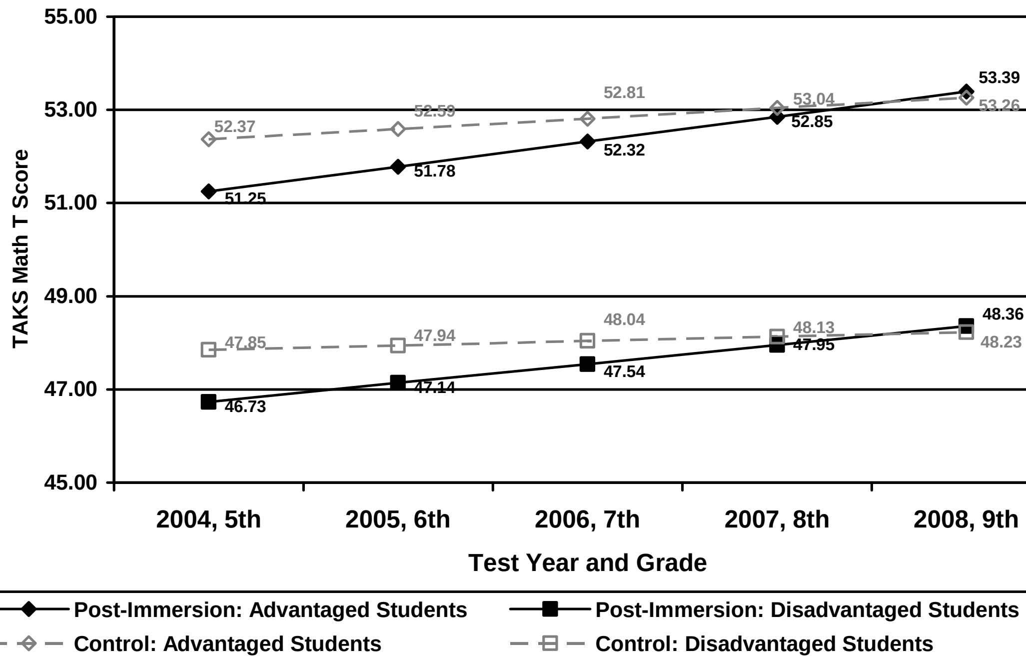


Figure 6.5. Estimated mean TAKS mathematics achievement growth trajectories for Cohort 1 economically advantaged and disadvantaged post-immersion and control students. The growth rate difference between the immersion and control groups is statistically insignificant.

Summary of Immersion Effects on TAKS Reading and Mathematics

Table 6.9 shows the estimated magnitude of the Technology Immersion effect (measured in standard deviation units) on TAKS reading and mathematics achievement across student cohorts. Estimated effects were generally modest but consistently favored Technology Immersion students compared to control. Although students' cumulative growth in *T*-score points varied for economically disadvantaged and non-disadvantaged students, differences between treatment and control groups reported in standard deviation units were identical for both groups (i.e., main effects estimates from HLM models). For TAKS reading, the sizes of effects in standard deviation units were very small but increased with longer exposure to Technology Immersion (.07 and .02 for Cohorts 1 and 2, respectively). Moreover, the positive Technology Immersion effect on students' reading achievement was sustained through ninth grade and approached statistical significance (.08, $p < .06$). The effects of Technology Immersion on TAKS mathematics achievement were larger than for reading. For TAKS math, the sizes of effects in standard deviation units for Cohort 2 (.20) and Cohort 3 (.16) were small but statistically significant ($p < .05$). The positive Technology Immersion effect on students' math scores was sustained through ninth grade. The estimated effect for Cohort 1, ninth graders (0.13) was similar to the magnitude of the effect in standard deviation units detected at the end of eighth grade.

Table 6.9. Model-Based Estimations of Technology Immersion Effects on TAKS scores by Subject, Economic Disadvantage Status, and Student Cohort

Assessment/Student Cohort	Cumulative Growth: Immersion *T*-score Growth	Cumulative Growth: Control *T*-score Growth	Cumulative Growth: Mean *T*-Score Difference	Standard Deviation Units
TAKS Reading, Advantaged				
Cohort 1: 9th graders, post-immersion	0.76	-0.06	0.81†	.08
Cohort 2: 8th graders, 3 immersion years	1.10	0.39	0.70	.07
Cohort 3: 7th graders, 2 immersion years	0.00	-0.21	0.21	.02
TAKS Reading, Disadvantaged				
Cohort 1: 9th graders, post-immersion	2.22	1.41	0.81†	.08
Cohort 2: 8th graders, three immersion years	2.02	1.32	0.70	.07
Cohort 3: 7th graders, two immersion years	0.22	0.01	0.21	.02
TAKS Mathematics, Advantaged				
Cohort 1: 9th graders, post-immersion	2.14	0.88	1.25	.13
Cohort 2: 8th graders, 3 immersion years	1.27	-0.69	1.96*	.20
Cohort 3: 7th graders, 2 immersion years	0.74	-0.83	1.57*	.16
TAKS Mathematics, Disadvantaged				
Cohort 1: 9th graders, post-immersion	1.63	0.38	1.25	.13
Cohort 2: 8th graders, three immersion years	1.81	-0.15	1.96*	.20
Cohort 3: 7th graders, two immersion years	0.09	-1.48	1.57*	.16

Note. Estimated *T*-score growth for students attending schools with average poverty. Cumulative growth in *T*-score units (mean= 50, standard deviation = 10). Standard deviation units = *T*-score difference/10.
†p < .10. *p < .05.

TAKS Social Studies and Science

Cohort 2 (Technology Immersion)

Cohort 2 students also completed TAKS science and social studies assessments in spring 2008. For science, eighth graders completed a baseline measure as fifth graders in 2005. The TAKS social studies assessment is administered for the first time in eighth grade. There was no baseline measure, so we used students' 2005 TAKS reading score as a control for academic achievement. The effects of immersion on Cohort 2 students' science and social studies scores were analyzed using two-level HLM models (see Table 6.10).

Table 6.10. HLM Statistics for Cohort 2 (Eighth Graders): Effect of Immersion (Fixed) on TAKS Science and Social Studies Achievement

	TAKS Science N = 3,268		TAKS Social Studies N = 3,268	
	Gamma Coefficient	*t*-value	Gamma Coefficient	*t*-value
Intercept (TAKS *T* score)	50.839	81.14***	51.850	53.95***
Immersion	0.475	0.65	0.006	0.01
School poverty	0.033	1.41	0.030	1.03
Female	-0.036	-0.13	-2.049	-6.75***
African American	-1.902	-2.43*	-1.938	-2.63**
Hispanic	-1.484	-3.01**	-1.058	-2.04*
Economic disadvantage	-1.611	-4.39***	-1.616	-3.29***
2005/2007 TAKS *T* score [a]	0.641	28.00***	0.537	27.88***

[a] The pre-measure for science is the 2005 TAKS science score; the pre-measure for TAKS social studies is the 2005 TAKS reading score. *p < .05. **p < .01. ***p < .001.

In the student-level model (Level 1), students' 2008 *T* scores were regressed on students' baseline scores, gender, minority status, and economic status. A school-level model (Level 2) was used to determine whether students in immersion schools had higher TAKS science and social studies scores than control-group students in spring 2008, after adjusting for initial achievement, student demographic characteristics, and school poverty. The immersion variable identified the comparison groups (a value of 1 for an immersion school and 0 for control). School poverty was a continuous variable, with a mean of 68.5%, indicating the percentage of economically disadvantaged students in a school.

Analyses for TAKS science and social studies involved 1,571 immersion students and 1,697 control students, with similar proportions of students included in analyses across groups (60.9% for immersion and 59.4% for control). Science outcomes show that after controlling for Cohort 2 students' prior TAKS achievement, demographic characteristics, and the level of school poverty, there was no statistically significant effect of immersion on eighth graders' 2008 TAKS science *T* scores. The immersion effect was positive (0.48 *T*-score point) but not by a significant margin. Results for TAKS social studies, showed that after controlling for students' 2007 TAKS reading achievement, demographic characteristics, and the level of school poverty, there was no statistically significant difference between the 2008 TAKS social studies *T* scores for immersion and control students. In contrast to science, the immersion effect on social studies was essentially zero (0.01 *T*-score point). Across both immersion and control schools, economically disadvantaged students had significantly lower TAKS science scores (-1.61 *T*-score points) and social studies scores (-1.62 *T*-score points) than their more affluent counterparts. And, minority students (African American and Hispanic) had significantly lower scores than other students. Unexpectedly, female students had significantly lower social studies scores than males (-2.05 *T*-score point).

TAKS Writing

Cohort 3 (Technology Immersion)

Cohort 3 students completed the TAKS writing assessment as fourth graders in 2005 and again as seventh graders in 2008. We used a two-level HLM model to estimate the effects of immersion on students' writing scores (see Table 6.11).

Table 6.11. HLM Statistics for Cohort 3 (Seventh Graders): Effects of Immersion (Fixed) on TAKS Writing Achievement

Dependent variable and predictor	TAKS Writing $N = 3{,}088$ Gamma Coefficient	*t*-value
Intercept (TAKS *T* score)	51.390	102.75***
Immersion	-0.723	-1.25
School poverty	0.003	0.17
Female	-0.218	-0.78
African American	-1.099	-2.60*
Hispanic	-0.407	-0.75
Economic disadvantage	-2.001	-5.91***
Spring 2005 *T* score	0.644	25.61***

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

In the student-level model (Level 1), students' 2008 writing *T* scores were regressed on 2005 writing scores (data from two years prior to students' involvement in the immersion project), gender, minority status, and economic status. A school-level model (Level 2) predicted whether students in immersion schools had higher 2008 TAKS writing *T* scores than control-group students, after adjusting for initial achievement, student demographic characteristics, and school poverty. HLM analyses involved 1,703 immersion students and 1,969 control students. Results show that after controlling for Cohort 3 students' pretest writing scores, student demographic characteristics (gender, ethnicity, economic status), and school poverty level, there was no statistically significant difference in the 2008 TAKS writing *T* scores for students in immersion and control schools. The immersion effect on writing was negative (about -0.72 *T*-score point lower than for control-group students). Across both immersion and control schools, the demographic characteristics of students were strongly associated with TAKS writing achievement. African American students (-1.10 *T*-score points) had significantly lower writing scores than other ethnic groups, and economically disadvantaged students had significantly lower scores (-2.00 *T*-score points) than their more affluent peers.

Conclusions

In the fourth and final project year, we examined the effects of Technology Immersion on Cohort 2 students (eighth graders who attended middle schools for three years), Cohort 3 students (seventh graders who attended middle schools for two years), and Cohort 1 students (ninth graders who attended middle schools for three years and then enrolled in mainly traditional high schools). Key findings are the following.

- **TAKS reading**. After controlling for student and school poverty, there were no statistically significant effects of immersion on the TAKS reading growth rates for either Cohort 2 students or Cohort 3 students. The immersion effects were positive but very small. Across both student cohorts, positive mean growth trajectories showed that economically disadvantaged students and students in schools with above average levels of poverty grew in reading achievement at faster rates than their more affluent peers. For Cohort 1, post-immersion and control ninth graders attending high schools, there was a positive enduring effect of Technology Immersion on treatment students' TAKS reading growth rate that approached statistical significance (p < .0.06).
- **TAKS mathematics.** After controlling for student and school poverty, Technology Immersion had a statistically significant effect on the TAKS mathematics growth rates for both Cohort 2 and Cohort 3 students. The TAKS mathematics scores of immersion students increased across years, whereas scores for control students decreased. For Cohort 1, post-immersion and control ninth graders attending high schools, there was a positive but statistically nonsignificant sustaining effect of Technology Immersion on TAKS mathematics achievement.
- **TAKS science.** After controlling for prior science achievement, demographic characteristics, and school poverty, there was no statistically significant effect of immersion on Cohort 2, eighth graders' 2008 TAKS science scores. The estimated immersion effect was positive but very small.
- **TAKS social studies.** After controlling for Cohort 2, eighth graders' reading achievement (seventh grade), demographic characteristics, and school poverty, there was no statistically significant effect of immersion on 2008 TAKS social studies scores. The estimated immersion effect was virtually zero (.006 *T*-score point).
- **TAKS writing.** After controlling for Cohort 3 seventh graders' pretest writing scores (fourth grade), demographic characteristics, and campus poverty, there was no statistically significant difference in the TAKS writing scores for immersion and control students. The estimated immersion effect was negative but very small.

7. Association between Implementation and Academic Outcomes

Chapter 3 provided findings on the implementation of Technology Immersion for the second through fourth project years (2005-06, 2006-07, and 2007-08, respectively). Implementation was measured as the fidelity with which Technology Immersion *components* and related *elements* attained the model's envisioned ideal (see implementation indicators in Exhibit 7.1). Mean immersion standard scores revealed small yearly increases across most of the implementation support components (Leadership, Teacher Support, Parent and Community Support, and Professional Development) as well as increases in teachers' overall level of Classroom Immersion. Conversely, the level of Student Access and Use declined across years, with notable fourth-year decreases in the frequency of Core-Content Learning and the extent of laptop use for Home Learning.

Exhibit 7.1. Implementation Indicators for Technology Immersion
Immersion Support Index is an aggregate score for school-level indicators of support for Technology Immersion. ▪ ***Leadership*** is a measure of administrative leadership for technology. ▪ ***Teacher Support*** is a measure of teachers' commitment to immersion. ▪ ***Parent and Community Support*** is a measure of support for the school's technology efforts. ▪ ***Technical Support*** is a measure of the extent to which technical support alleviates problems that create barriers to immersion. ▪ ***Professional Development*** is an aggregate indicator of the quality of campus professional development as measured by four elements: *Contact Hours, Classroom Support, Content Focus,* and *Coherence.*
Classroom Immersion Index is an aggregate score for teacher-level immersion indicators. ▪ ***Technology Integration*** is a measure of a teacher's ideological orientation towards classroom Technology Immersion. ▪ ***Learner-Centered Instruction*** is a measure of a teacher's ideological orientation towards student-centered learning practices. ▪ ***Student Activities*** is a measure of the frequency of students' use of technology resources in a teacher's classroom. ▪ ***Communication*** is a measure of a teacher's technology-based communications with students, parents, and peers. ▪ ***Professional Productivity*** is a measure of a teacher's use of technology for professional activities.
Student Access and Use Index is an aggregate score for student-level immersion indicators. ▪ ***Laptop Access Days*** is a measure of the extent to which a student has access to a laptop throughout the school year. ▪ ***Core-Content Learning*** is a measure of the frequency that a student reports using technology for learning in core-subject classes. ▪ ***Home Learning*** is a measure of the extent that a student uses a laptop for core-subject homework (language arts [reading/writing], social studies, science, and math) or to play games to learn outside of school.
Implementation Index is an implementation score for each school, which is an aggregate score for the three implementation components described above.
Note. Implementation indices are *z* scores with a mean of 0 and standard deviation of 1.0.

Implementation evidence for the fourth year, similar to previous years, revealed wide variation across schools and classrooms. For the fourth year, we estimated that about a quarter of middle schools (6) had a much stronger presence of the immersion components that more nearly approximated full implementation standards. Given variations in implementation from school-to-school and from classroom-to-classroom, we report in this chapter on the relationships between implementation levels and student academic achievement. For analyses, we used standardized implementation indicators (z scores with a mean of 0 and a standard deviation of 1.0) that could be analyzed individually or aggregated to generate component scores and an overall implementation score. Analyses involved indicators that assessed school supports for immersion (Immersion Support Index), the extent of teachers' classroom immersion (Classroom Immersion Index), and the extent of students' technology access and use (Student Access and Use Index).

Analysis Method

We used a series of two-level hierarchical linear models (HLM), in which students were nested within teachers' classrooms, to investigate whether the levels of implementation for two teacher-related implementation components (Immersion Support Index, Classroom Immersion Index) and one student-specific component (Student Access and Use Index) were significant predictors of students' TAKS reading and mathematics scores. We analyzed the effects of implementation on academic achievement for Cohorts 2 and 3 students.

In the student-level model (Level 1), 2008 TAKS *T* scores were regressed on 2007 TAKS *T* scores, the Student Access and Use Index (z score), 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). The teacher-level model (level 2) investigated whether the Immersion Support Index (average campus z score) and Classroom Immersion Index (individual teacher z score) predicted higher 2008 TAKS scores, after adjusting for school poverty, students' prior achievement and demographic characteristics, and Student Access and Use. We also investigated whether Student Access and Use predicted higher 2008 TAKS scores, after adjusting for initial achievement, student demographic characteristics, school poverty, Immersion Support, and Classroom Immersion. School poverty was a continuous variable indicating the percentage of economically disadvantaged students in a school, with a mean of 71.0%. Analyses for Cohorts 2 and 3, respectively, involved approximately 1,100 students who were enrolled continuously in schools during three project years and 1,200 students who were continuously enrolled for two project years.

TAKS Reading

Estimates of the effects of implementation on Cohorts 2 and 3 students' 2008 TAKS reading *T* scores are presented in Table 7.1. At the teacher level, we investigated whether the strength of reading teachers' campus support for implementation (Immersion Support) and their reported levels of Classroom Immersion were predictors of students' reading achievement. None of the teacher-level implementation measures were statistically significant predictors of TAKS reading scores. After controlling for student variables (prior achievement, demographic characteristics, Student Access and Use) and other teacher variables (school poverty and Classroom Immersion), Immersion Support was a positive predictor of Cohort 2 eighth graders' reading achievement but a negative predictor of Cohort 3 students' reading scores. Reading teachers' level of Classroom Immersion was a consistently positive predictor of students' TAKS reading achievement. After adjusting for other variables in the analysis, Cohorts 1 and 2 students who had reading teachers with average levels of Classroom Immersion had slightly higher TAKS reading *T*-scores (0.22 and 0.21 points, respectively) than students with teachers having below average Classroom Immersion scores.

Table 7.1. Hierarchical Regression Models Predicting the Effects of Implementation Components on TAKS Reading Achievement

Predictor	Cohort 2 Eighth Graders N = 1,101 Gamma Coefficient	Cohort 2 Eighth Graders N = 1,101 *t*-value	Cohort 3 Seventh Graders N = 1,168 Gamma Coefficient	Cohort 3 Seventh Graders N = 1,168 *t*-value
Intercept	50.264	128.56***	49.204	99.61***
Teacher-level predictors				
School poverty	-0.016	-1.18	-0.021	-1.15
Immersion Support	0.064	0.52	-0.315	-1.16
Classroom Immersion	0.215	1.45	0.211	0.73
Student-level predictors				
Spring 2007 *T* score	0.689	21.38***	0.666	34.78***
Student Access and Use	0.466	1.38	0.791	1.93†
Female	0.674	1.95†	0.216	0.52
African American	-1.862	-2.12*	-1.649	-2.18*
Hispanic	-0.164	-0.43	-0.518	-0.83
Eco. Disadvantaged	-0.601	-1.33	-0.875	-1.63

$^{\dagger}p < .10$. $*p < .05$. $**p < .01$. $***p < .001$.
Note. Numbers of reading teachers: Cohort 2 = 37 and Cohort 3 = 34.

In contrast to teacher-level predictors, the level of Student Access and Use (of technology) was a stronger predictor of reading achievement, but the effect was non-significant for Cohort 2 and just marginally statistically significant for Cohort 3. Hence, after controlling for students' prior reading achievement, demographic characteristics, and teacher-level variables (school poverty and implementation components), the sizes of the Student Access and Use effect on TAKS reading achievement for Cohorts 2 and 3 students were 0.47 and 0.79 *T*-score points, respectively.

Additionally, we conceptualized Student Access and Use as having multiple elements (Laptop Access Days, Core-Content Learning, and Home Learning), and thus, were interested in separately predicting variation for each element. Table 7.2 provides statistics for the HLM models used to predict each of the three elements. Findings revealed that Home Learning—which measured the extent of a student's laptop use outside of school for homework in each of the four core-subject areas and for learning games—was the strongest implementation predictor of reading achievement. The Home Learning effect on TAKS reading scores was positive for Cohort 2 (0.30 *T*-score point) and statistically significant and positive for Cohort 3 (0.99 *T*-score point). As an example, after controlling for all of the other variables in the analysis, an economically advantaged, non-minority, male seventh grader with a score one standard deviation above average for Home Learning ($z = 1.00$), had a 0.99 *T*-score point higher TAKS reading score. Moreover, with each additional standard deviation increase in Home Learning, students' reading achievement increased even more.

In contrast to Home Learning, the number of days during the school year that students had laptops available for use (Laptop Access Days) was a mixed and non-significant predictor of students' reading achievement. The frequency that students reported using their laptops in their four core-subject classes (Core-Content Learning) was a non-significant and negative predictor of achievement for both Cohorts 2 and 3, after controlling for other variables in the analysis.

Table 7.2. Hierarchical Regression Models Predicting the Effects of Implementation Components (including Elements of Student Access and Use) on TAKS Reading Achievement

Predictor	Cohort 2 Eighth Graders		Cohort 3 Seventh Graders	
	Gamma Coefficient	*t*-value	Gamma Coefficient	*t*-value
Intercept	50.326	126.61***	49.274	100.01***
Teacher-level predictors				
School poverty	-0.019	-1.32	-0.032	-1.88†
Immersion Support	0.105	0.85	-0.263	-0.98
Classroom Immersion	0.239	1.55	0.365	1.41
Student-level predictors				
Spring 2007 *T* score	0.686	20.83***	0.658	34.87***
Laptop Access Days	0.195	0.89	-0.186	-0.73
Core-Content Learning	-0.098	-0.41	-0.344	-1.54
Home Learning	0.304	1.27	0.985	4.77***
Female	0.641	1.88†	0.152	0.37
African American	-1.872	-2.12*	-1.624	-2.27*
Hispanic	-0.202	-0.52	-0.648	-1.07
Eco. Disadvantaged	-0.627	-1.39	-0.765	-1.41

†$p < .10$. *$p < .05$. **$p < .01$. ***$p < .001$.

Note. Numbers of reading teachers: Cohort 2 = 37 and Cohort 3 = 34.

TAKS Mathematics

We also estimated the effects of implementation on students' 2008 TAKS mathematics *T* scores. Like reading, we examined implementation effects for students and teachers (Table 7.3).

Table 7.3. Hierarchical Regression Models Predicting the Effects of Implementation Components and TAKS Mathematics Achievement

Predictor	Cohort 2 Eighth Graders *N* = 999		Cohort 3 Seventh Graders *N* = 1,165	
	Gamma Coefficient	*t*-value	Gamma Coefficient	*t*-value
Intercept	50.542	108.15***	50.313	101.20***
Teacher-level predictors				
School poverty	0.011	0.57	-0.010	-0.40
Immersion Support	-0.168	-0.55	0.026	0.07
Classroom Immersion	0.451	1.03	-0.614	-1.49
Student-level predictors				
Spring 2007 *T* score	0.702	32.65***	0.730	35.24***
Student Access and Use	0.303	1.01	0.505	1.39
Female	-0.338	-0.86	0.509	1.78†
African American	-1.528	-2.19*	-2.475	-2.74**
Hispanic	-0.436	-1.08	-0.998	-1.73†
Eco. Disadvantaged	-0.607	-1.41	-0.632	-1.26

†$p < .10$. *$p < .05$. **$p < .01$. ***$p < .001$.

Note. Numbers of mathematics teachers: Cohort 2 = 37 and Cohort 3 = 38.

Comparable to reading, none of the teacher-level implementation indicators was a statistically significant predictor of students' TAKS mathematics scores. After controlling for other variables in the analysis, Immersion Support was a negative predictor of Cohort 2 students' mathematics achievement and a positive predictor of achievement for Cohort 3. After statistical adjustments for the other variables in the analysis, mathematics teachers' reported Classroom Immersion level was a positive predictor of TAKS math achievement for Cohort 2 but a negative predictor for Cohort 3. In contrast to teacher-related implementation indicators, students' reported level of Student Access and Use was a consistently positive predictor of 2008 TAKS mathematics *T* scores for each of the student cohorts, although not by a statistically significant margin. Controlling for students' prior math achievement, demographic characteristics, and teacher-level variables (implementation components as well as school poverty), the sizes of the Student Access and Use effects were 0.30 and 0.51 *T*-score points for Cohorts 2 and 3 students, respectively.

To gain a greater understanding of the association between students' reported technology access and use and mathematics achievement, we used HLM to predict math achievement for each of the three Student Access and Use elements (Laptop Access Days, Core-Content Learning, and Home Learning). Results in Table 7.4, similar to TAKS reading outcomes, show that the extent to which students reported using their laptops for Home Learning was a statistically significant predictor of TAKS mathematics scores. The Home Learning effect on mathematics achievement was slightly stronger for Cohort 3 (0.48 *T*-score point) compared to Cohort 2 (0.32 *T*-score point). As an example, after controlling for the other variables, an economically advantaged, non-minority, male seventh grader with a Home Learning score about one standard deviation above average ($z = 0.99$), had a 0.48 *T*-score point higher TAKS mathematics score. As the extent of laptop use for Home Learning increased, mathematics achievement increased incrementally.

Table 7.4. Hierarchical Regression Models Predicting the Effects of Implementation Components (Including Elements of Student Access and Use) on TAKS Mathematics Achievement

	Cohort 2 Eighth Graders		Cohort 3 Seventh Graders	
Predictor	Gamma Coefficient	*t*-value	Gamma Coefficient	*t*-value
Intercept	50.588	109.51***	50.343	98.36***
Teacher-level predictors				
School poverty	0.007	0.35	-0.013	-0.51
Immersion Support	-0.159	-0.52	0.214	0.57
Classroom Immersion	0.416	0.98	-0.584	-1.42
Student-level predictors				
Spring 2007 *T* score	0.698	33.54***	0.725	35.57***
Laptop Access Days	0.019	0.12	0.181	0.72
Core-Content Learning	-0.146	-0.72	-0.322	-1.70†
Home Learning	0.324	1.74†	0.482	2.07*
Female	-0.376	-0.98	0.438	1.48
African American	-1.542	-2.23*	-2.418	-2.70**
Hispanic	-0.442	-1.10	-1.017	-1.78†
Eco. Disadvantaged	-0.627	-1.48	-0.605	-1.19

†$p < .10$. *$p < .05$. **$p < .01$. ***$p < .001$.
Note. Numbers of mathematics teachers: Cohort 2 = 37 and Cohort 3 = 38.

In contrast to Home Learning, students' reported number of Laptop Access Days was a positive but non-significant predictor of TAKS mathematics achievement across the two student cohorts. Conversely, the frequency of laptop use for Core-Content Learning in classrooms was negatively associated with students' mathematics achievement for both cohorts, with the negative relationship marginally statistically significant for Cohort 3.

Conclusions

In this chapter we described associations between the implementation of Technology Immersion components and students' academic achievement. Key findings are the following.

- Data analyses for individual students and their teachers showed that the campus measure of Immersion Support and reading and mathematics teachers' reported levels of Classroom Immersion were inconsistent predictors of students' TAKS reading and mathematics achievement.
- Conversely, the level of Student Access and Use (of technology) was a consistently positive although not statistically significant predictor of students' TAKS reading and mathematics achievement for Cohort 2 (eighth graders) and Cohort 3 (seventh graders). Student Access and Use was a marginally statistically significant predictor of TAKS reading scores for Cohort 3 students.
- Of the three elements of Student Access and Use, students' use of their laptops for Home Learning—a measure of the extent to which a student used a laptop outside of school for homework in the four core-subject areas and for learning games—was the strongest implementation predictor of TAKS reading and mathematics achievement across both cohorts.
- For Cohort 2 (eighth graders), the extent of Home Learning was a positive but non-statistically significant predictor of students' TAKS reading achievement and a positive and marginally significant predictor of TAKS mathematics achievement. For Cohort 3 (seventh graders), the extent of Home Learning was a positive and statistically significant predictor of both TAKS reading and mathematics achievement.

8. Conclusions and Implications

The fourth-year evaluation provides final results on the effects of the Technology Immersion model (i.e., a laptop computer for every student and teacher, wireless access throughout the campus, curricular and assessment resources, professional development, and ongoing technical and pedagogical support) on schools, teachers, and students. This report combines information gathered during the fourth project year (2007-08) with data from the first through third implementation years (2004-05 through 2006-07).

The study's quasi-experimental research design has allowed inferences about causal effects through comparisons between 21 treatment schools and 21 control schools. Schools included Grades 6 to 8 middle schools drawn from rural, suburban, and urban locations across Texas. Middle schools were typically small (about 400 students, on average); however, enrollments varied widely (from 83 to 1,447 students). About two-thirds of schools were located in small or very small Texas districts (less than 3,000 students), and about a third were in very large districts (10,000 or more students). Students in the study were mostly economically disadvantaged (67%) and they were racially and ethnically diverse (roughly 58% Hispanic, 7% African American, and 36% White).

The study focused on three student cohorts in the fourth year. Cohort 2 included eighth graders (2,578 treatment and 2,858 control students) who finished their third immersion year; Cohort 3 included seventh graders (2,547 treatment and 2,845 control students) who concluded their second year. In the fourth year, we also examined achievement data for Cohort 1students who had attended Technology Immersion and control schools from sixth-through-eighth grade and then enrolled in traditional high schools, which typically did not provide individual laptops for students (2,469 treatment students and 2,748 control-group students).

Study Limitations

The sample selection process and matching procedures used with the quasi-experimental design produced a sample of schools with good internal validity, in that there were no large, statistically significant treatment-control group differences. Baseline data confirmed that the comparison groups were reasonably well matched, but we have also used statistical controls to adjust for differences that could have arisen from sampling variability. A threat to internal validity was introduced in the third year when control schools began to plan for Technology Immersion. Most of the control teachers received laptops, instructional resources, and more intensive professional development in the third year, and in the fourth project year, some students at control schools received laptops. In particular, records submitted by schools indicated that about 260 eighth graders (9%) and 480 seventh graders (17%) at control schools received individual laptops during the fourth year. The introduction of Technology Immersion components in control schools may bias fourth-year results. Given the positive associations between Technology Immersion and teacher and student outcomes identified across three project years, reported findings may underestimate the magnitude of the treatment effect. On the other hand, given that some studies show schools' academic outcomes may decline during initial implementation phases (Borman, Hewes, Overman, & Brown, 2003; Borman, 2005), the introduction of Technology Immersion components in control schools might positively bias outcomes for treatment schools.

Generalization of findings to a broader population (external validity) is a primary study limitation. Compared to Texas middle-school students as a whole, students in the sample schools are substantially more Hispanic and less White and African American. Middle schools are also smaller than the statewide average (402 students versus 667). Schools also are located either in small or very small districts (64%) or large districts (36%), which is different from the statewide distribution of schools. Additionally, for many variables, the study relies on self-reported data from surveys of teachers and students—thus, some findings on changes in proficiencies and practices reflect respondents' perceptions. Nonetheless, the triangulation of evidence from multiple sources (surveys, classroom observations, state demographic and test databases, multiple student cohorts) verifies the robustness of findings. Despite cited limitations, researchers are confident that reported effects can be attributed to the treatment.

Major Fourth-Year Findings

Like previous years, outcomes represent the effects of Technology Immersion for schools that generally had less than full implementation levels. Although the overall quality of schools' implementation improved slightly in the fourth year, we estimated that just a quarter of middle schools (6) achieved *substantial immersion* levels, whereas the remaining schools (15) had *minimal* to *partial immersion* levels. Major findings from the fourth year are described in the following sections. A final section discusses the quality of Technology Immersion implementation, prospects for sustainability of the model, and implications for educational policy.

Effects of Technology Immersion on Teachers and Teaching

We assessed the effects of Technology Immersion on teachers and teaching by examining teachers' rates of growth on mediating variables across five time points (fall 2004 through spring 2008). Analyses involved 2,137 teachers, including 1,046 in immersion schools and 1,091 in control schools. Even though control teachers benefited in the third and fourth years from initial steps toward implementation of the Technology Immersion model, we found that being part of a Technology Immersion school across four years affected teachers positively in a number of ways.

Teachers in Technology Immersion schools grew in technology proficiency, their use of technology for professional productivity, and their use of technology for student learning activities at significantly faster rates than control teachers. Although both treatment and control teachers became more technology literate over time, immersion teachers grew at a significantly faster pace. Teachers' self-assessments of Technology Proficiency across time indicated that immersion teachers were increasingly more accomplished than control teachers in areas involving technology operations (e.g., using software applications) and pedagogical skills (e.g., creating lessons plans integrating technology). Estimated yearly growth trajectories for immersion teachers in schools with average student poverty, compared to control, were nearly twice as steep (0.29 and 0.15 scale-score points per year, respectively, on a 7-point scale). Consistent with previous years, teachers who taught at schools with higher levels of student poverty grew in technology proficiency at significantly slower rates than their peers in more advantaged schools. As the level of school poverty increased, the proficiency gap between teachers in higher and lower poverty schools widened.

Teachers at Technology Immersion schools also grew in their use of technology to enhance their Professional Productivity at a significantly faster rate than control teachers (0.18 and 0.11 scale-score points per year, respectively, on a 5-point scale). However, the gap between teacher groups narrowed substantially in the third and fourth years as teachers in control schools acquired more technology resources. Consequently, teachers at both treatment and control schools were using technology more frequently for purposes such as making electronic presentations, administering online assessments, and accessing model lesson plans.

Teachers at Technology Immersion schools, who continued to have greater classroom access to computers than control teachers, increased the frequency of their students' Classroom Activities involving technology at a more rapid pace (0.17 scale-score point per year on a 5-point scale versus 0.07 point, for teachers in schools with average poverty). Although student activities with technology increased steadily across years in immersion classrooms, fourth-year averages showed that students as a whole still used various technology resources infrequently (i.e., about once or twice a month, $M = 2.72$). Mean statistics, however, obscured the substantial teacher-to-teacher variation in the frequency of students' technology activities both across and within subject areas. Similar to previous years, English language arts, science, and social studies teachers had students use technology considerably more often than mathematics teachers.

Teachers at Technology Immersion schools expressed significantly stronger ideological associations across years with technology integration and learner-centered practices. Teachers at both immersion and control schools became more positive towards innovative technology practices across years, but immersion teachers altered their beliefs at a significantly faster rate. For Technology Integration, the mean estimated growth for immersion teachers in schools with average poverty was 0.40 scale-score point per year compared to 0.30 for control teachers (on a 7-point scale). Thus, immersion teachers increasingly employed actions supporting curricular and instructional infusion of technology, such as promoting students' authentic problem solving or critical thinking through technology. Immersion teachers also expressed increasingly stronger affiliations with constructivist or learner-centered practices, such as having students establish individual learning goals and emphasizing experiential learning. The estimated yearly growth rates in learner-centered practices for immersion and control teachers in average poverty schools were 0.31 and 0.20 scale-score points, respectively, on a 7-point scale.

The introduction of Technology Immersion components in schools affected teachers' perceptions of the school's culture as well as the frequency of teachers' collegial interactions. Our study, similar to others, shows that the introduction of technology resources can be a catalyst for school change (e.g., Baker et al., 1994; Dwyer, 1994). Across the first two project years, teachers in immersion schools compared to control reported significantly stronger administrative leadership for technology, greater parent and community support for technology, a more innovative school culture, and increased collaborative interactions with colleagues that supported improvements in instructional practices (such as coaching and mentoring, developing lesson plans collectively, exchanging information about students). With the introduction of teacher laptops and other technology resources in control schools during the third and fourth project years, differences between the views of treatment and control teachers dissipated. Similar to treatment teachers, the teachers in control schools began to perceive stronger administrative leadership and collective teacher support for technology. Thus, as control teachers experienced components of Technology Immersion, they also began to view their schools' technology environments as more innovative and supportive. Still, teachers at Technology Immersion schools who had access to professional development and technology resources over a longer period of time continued in the fourth year to report more frequent collaborative interactions with their colleagues that supported instructional practices involving technology (e.g., developing lesson plans or exchanging information about students) compared to control teachers.

Evidence from classroom observations suggested that laptop computers and digital resources allowed students in Technology Immersion schools to experience somewhat more intellectually demanding work. The Technology Immersion model assumes that technology resources will promote students' higher level thinking through more challenging and relevant learning activities that support academic achievement. Accordingly, across four years, researchers have observed lessons in immersion and control teachers' classrooms and rated the Intellectual Challenge of lessons (Newmann et al., 1995). Observations of core-subject classes (English language arts/reading, mathematics, science, and social studies) revealed no statistically significant differences between the overall Intellectual Challenge of immersion and control teachers' instruction. However, effect sizes measuring differences between treatment and control teachers' instruction generally showed positive effects favoring treatment teachers, especially for the domains measuring Higher Order Thinking (e.g., synthesizing, generalizing, explaining) and Depth of Knowledge (e.g., thorough exploration of a topic that produces complex understandings). Longitudinal trends indicated that the introduction of technology resources had a similarly positive influence on control teachers' instruction. Still, despite positive progress, results for *all* observed classrooms indicated that lessons in middle school core-subject classes generally failed to intellectually challenge students, with average ratings in the fourth year of about 2 on the 5-point challenge scale.

Effects of Technology Immersion on Students and Learning

In the fourth project year, we measured student mediating variables across four time periods for Cohort 2 eighth graders (fall 2005 and spring 2006, 2007, and 2008) and three periods for Cohort 3 seventh graders (fall 2006 and spring 2007 and 2008). Analyses for Cohorts 2 and 3, respectively, included 2,167 immersion and 2,361 control students, and 2,073 immersion and 2.372 control students. Controlling for important school and student characteristics, key findings included the following.

Economically advantaged and disadvantaged students in Technology Immersion schools became significantly more technology proficient than their counterparts in control schools. Economically disadvantaged students in immersion schools reached proficiency levels that matched the skills of advantaged control students. Across implementation years and student cohorts, students in Technology Immersion schools have made significantly greater progress in mastering the Texas Technology Applications standards than control students (e.g., sending an email attachment, creating a presentation, managing documents, using spreadsheets, and keeping track of websites). For Cohort 2 (eighth graders), both economically advantaged and disadvantaged immersion students grew in proficiency at faster rates (0.35 and 0.35 scale-score points per year, respectively, on a 5-point scale) than their control-group counterparts (0.26 and 0.26 scale-score points). For Cohort 3 (seventh graders) the immersion effect was even stronger, with both economically advantaged and disadvantaged immersion students growing significantly faster in proficiency (0.43 and 0.42 scale-score points per year, respectively) than control-group students (0.27 and 0.26 scale-score points, respectively). As a consequence, economically disadvantaged students in Technology Immersion schools reached levels of technical proficiency that equaled the proficiencies of advantaged students in control schools.

Students in Technology Immersion schools used technology applications more often in their core-subject classes and they interacted more often with their peers in small-group activities. Similar to previous evaluation years, students in immersion schools used technology applications significantly more often in their core-subject classes than control students. For Cohorts 2 and 3, the yearly growth rates in Classroom Activities for economically advantaged and disadvantaged immersion students ranged from 0.19 to 0.43 scale-score points (on a 5-point scale), compared to 0.10 to 0.21 points for comparable control-group students. Despite significant yearly increases, fourth-year scores (similar to teachers' reports) indicated that students, on average, used various technology resources infrequently in core classes (about once or twice a month).

Along with greater uses of classroom technology, students in immersion schools also had more frequent opportunities to learn in small groups with their classmates. Seventh and eighth graders in immersion schools had increasing opportunities for small-group work with their peers, whereas their counterparts in control schools reported less frequent small-group activities as they advanced to higher grade levels. Thus, as immersion teachers acquired new resources, many teachers began to alter their instructional practices and started to organize student classroom activities differently.

As laptops aged over four years, students at Technology Immersion schools, compared to control, reported more technical problems when they used computers at school. In the fourth year, students in Technology Immersion schools reported technical problems with computers at more than twice the rates reported by control students. Eighth graders (Cohort 2) who often inherited second-hand laptops and had used those laptops across three school years, and seventh graders (Cohort 3) who also often inherited and used worn laptops, reported significantly more technical problems than control-group students. Mean scores reported by students in spring 2008 indicated that various technical problems occurred rarely (a few times a year) or just sometimes (once or twice a month). However, increased problems with deteriorating laptops substantially increased the workloads of technical-support staff, which in many cases were already overburdened with technical demands.

Across four evaluation years, there was no evidence linking Technology Immersion with student self-directed learning or their general satisfaction with schoolwork. Some research studies have suggested that the independent and self-guided learning afforded through one-to-one technology will positively affect students' personal self-direction (e.g., Garrison, 1997; Raghavan, Sartoris, & Glaser, 1997; Zimmerman, 1989). However, findings from three student cohorts across four evaluation years showed there was no statistically significant effect of Technology Immersion on student Self-Directed Learning, as measured by the *Style of Learning Inventory*. Across years, as both immersion and control students progressed from lower to higher grade levels, their responses to statements measuring self-direction (e.g., goal setting, self-efficacy beliefs, and intrinsic effort) revealed significantly negative growth trends. Thus, students reported less self-regulated learning behaviors across time. We also measured students' levels of satisfaction with the kinds of work they did in classes (e.g., meaningfulness of class work) and with their perceived relevance of schoolwork (e.g., usefulness for the future). We found that the excitement of having laptops appeared to elevate the satisfaction of sixth graders during their first middle-school year. However, as students advanced to seventh and eighth grade, there was no significant difference in the levels of satisfaction with schoolwork expressed by treatment and control students. Across *all* middle schools, students' responses to statements related to their understanding about why they do certain things in classes, the extent that meaningful work makes them try harder, and beliefs that class work will help them as adults or in future jobs moved toward *uncertainty* or *disagreement* and away from *agreement.*

Across four years, students in Technology Immersion schools consistently had fewer disciplinary actions than control-group students. Consistent with previous research linking one-to-one computing with reduced student discipline problems (e.g., Baldwin, 1999; Barron, Hogarty, Kromery, & Lenkway, 1999; MEPRI, 2003; Stevenson, 1998), results replicated across three student cohorts for this study showed that students at Technology Immersion schools had significantly fewer disciplinary problems. Disciplinary Action Reports submitted to the Texas Education Agency (TEA) for each student during the 2007-08 school year, similar to the previous three years, showed that immersion students had proportionately fewer disciplinary actions than their counterparts in control schools. In the fourth year, Cohorts 2 and 3 immersion students had an average of 0.54 and 0.45 disciplinary actions per student, respectively, compared to 0.76 and 0.71 per-student averages for control students. Even though the effect sizes for the mean differences between groups were small (-.11 and -.13), the reduction in disciplinary actions in middle schools may have practically important benefits due to increased learning time for students that remained in classrooms, and decreased time and effort expended by teachers and administrative staff in addressing the disciplinary problems of students removed from classrooms.

For the first-through-third evaluation years, students at Technology Immersion schools had significantly lower school attendance rates than control students—however, in the fourth year, differences between the attendance rates of treatment and control students were smaller and statistically nonsignificant. Previous studies of technology projects have linked one-to-one computing with fewer school absences and late arrivals compared to non-laptop students (e.g., Stevenson, 1999). Across the first three evaluation years, in contrast to previous studies, our research has shown that students at Technology Immersion schools attended school *less* regularly than control students. For example, economically advantaged Cohort 2 (seventh graders) had an average attendance rate of 96.9% compared to 97.2% for control students, and economically disadvantaged immersion students, similarly, had significantly lower attendance rates than control-group students (95.9% versus 96.3%). In the fourth year, economically advantaged and disadvantaged Cohort 2 students at immersion schools (who were now eighth graders) continued to have slightly lower attendance rates (96.6% and 95.4%, respectively) than their control-group counterparts (97.0% and 95.8%, respectively), but the school attendance rate differences between groups were extremely small and not statistically significant. Likewise, the attendance-rate differences for Cohort 3 treatment and control students (seventh graders) were very small and statistically insignificant in the fourth year.

In previous years, we conjectured that the lower school attendance rates of immersion students might reflect the tendency for some students to occasionally skip school in order to use their laptops at home. In the fourth year, as noted previously, some control students also received individual laptops (about 9% and 17% of Cohorts 2 and 3 control students, respectively). Thus, it is feasible that the introduction of laptops in control schools had a slightly negative effect on those students' school attendance rates (similar to the lower attendance of immersion students). In any case, as detailed in the section below, the modestly lower average school attendance rates of immersion students across years have not been associated with lower academic achievement.

Effects of Technology Immersion on Academic Achievement

Increasing middle-school students' academic achievement in core subjects as measured by state assessments was the ultimate goal of Technology Immersion. For analyses reported below, students' Texas Assessment of Knowledge and Skills (TAKS) scale scores were standardized as *T* scores with a mean of 50 and a standard deviation of 10. Analyses for Cohort 2 (eighth graders) included about 1,570 immersion and 1,700 control students; Cohort 3 (seventh graders) included about 1,690 immersion and 1,970 control students. We also investigated the TAKS performance of Cohort 1 students (ninth graders) who attended Technology Immersion and control schools from sixth-through-eighth grade and then enrolled in traditional high schools, which typically did not provide individual laptops for students, through TAKS testing in spring 2008.

Longitudinal data across multiple student cohorts has allowed researchers to examine the replicability of achievement effects. Given that small effects are noteworthy when effects are replicated (e.g., Abelson, 1985; Cohen, 1994; Schmidt, 1996), we have reported some effects as statistically significant using a less stringent criterion ($p = < .10$) if findings provided evidence substantiating important trends. Students completed TAKS tests annually in reading and mathematics, so the evidence of immersion effects is stronger for those subject areas. In contrast, evidence for science, social studies, and writing is limited because students' completed those assessments at periodic intervals.

Table 8.1 summarizes the estimated magnitude of the Technology Immersion effect on TAKS reading and mathematics achievement across student cohorts. Estimated effects are described as the cumulative growth in *T*-score units for Technology Immersion and control groups, the mean cumulative growth differences between groups in *T*-score units, and the estimated sizes of the effects in standard deviation units. Major findings on the effects of Technology Immersion on TAKS achievement follow the table.

Table 8.1. HLM Model-Based Estimations of Technology Immersion Effects on TAKS scores by Subject, Economic Disadvantage Status, and Student Cohort

Assessment/Student Cohort	Cumulative Growth: Immersion *T*-score Growth	Control *T*-score Growth	Mean *T*-Score Difference	Standard Deviation Units
TAKS Reading, Advantaged				
Cohort 1: 9th graders, post-immersion	0.76	-0.06	0.81†	.08
Cohort 2: 8th graders, 3 immersion years	1.10	0.39	0.70	.07
Cohort 3: 7th graders, 2 immersion years	0.00	-0.21	0.21	.02
TAKS Reading, Disadvantaged				
Cohort 1: 9th graders, post-immersion	2.22	1.41	0.81†	.08
Cohort 2: 8th graders, three immersion years	2.02	1.32	0.70	.07
Cohort 3: 7th graders, two immersion years	0.22	0.01	0.21	.02
TAKS Mathematics, Advantaged				
Cohort 1: 9th graders, post-immersion	2.14	0.88	1.25	.13
Cohort 2: 8th graders, 3 immersion years	1.27	-0.69	1.96*	.20
Cohort 3: 7th graders, 2 immersion years	0.74	-0.83	1.57*	.16
TAKS Mathematics, Disadvantaged				
Cohort 1: 9th graders, post-immersion	1.63	0.38	1.25	.13
Cohort 2: 8th graders, three immersion years	1.81	-0.15	1.96*	.20
Cohort 3: 7th graders, two immersion years	0.09	-1.48	1.57*	.16

Note. Estimated *T*-score growth for students attending schools with average levels of poverty. Cumulative growth in *T*-score units (mean= 50, standard deviation = 10). Standard deviation units = *T*-score difference/10.
†$p < .10$. *$p < .05$.

Technology Immersion had no statistically significant effect on TAKS reading achievement for Cohort 2 (eighth graders) or Cohort 3 (seventh graders)—however, for Cohort 1 (ninth graders), there was a marginally significant and positive sustaining effect of Technology Immersion on students' TAK reading scores. After controlling for student and school poverty, there were no statistically significant effects of immersion on the TAKS reading growth rates for either Cohort 2 (eighth graders) or Cohort 3 (seventh graders). The immersion effects were positive but not by statistically significant margins. For Cohort 1 (ninth graders) there was a statistically significant and positive sustaining effect of immersion on the TAKS reading growth rates of students who had attended immersion middle schools and then moved on to mainly traditional high schools ($p < .06$). The reading achievement of post-immersion students increased by 0.19 *T*-score point per year, whereas the achievement of control ninth graders decreased by about 0.01 *T*-score point per year. Across Cohorts 1 and 2, economically disadvantaged students grew in reading achievement at significantly faster rates than their more affluent peers (0.56 and 0.67 *T*-score points per year for immersion students, respectively; 0.35 and 0.44 *T*-score points for control-group students, respectively). For TAKS reading, the sizes of immersion effects in standard deviation units (.08, .07, and .02) were very small but increased with longer exposure to Technology Immersion and through the post-immersion year in high school.

Technology Immersion had a statistically significant effect on TAKS mathematics achievement for Cohort 2 (eighth graders) and Cohort 3 (seventh graders). For Cohort 1 (ninth graders), the sustaining effect of immersion on TAKS mathematics scores was positive but not by a statistically significant margin. After controlling for student and school poverty, Technology Immersion had a statistically significant effect on students' growth rates for TAKS mathematics ($p < .05$) for Cohorts 2 and 3 students. Estimated yearly TAKS mathematics growth rates for economically advantaged students in immersion schools (0.42 and 0.37 *T*-score points per year for

Cohorts 2 and 3, respectively) significantly outpaced their control-group counterparts (-0.23 and -0.42 *T*-score points, respectively). Similarly, estimated yearly TAKS mathematics growth rates for economically disadvantaged students in immersion schools (0.60 and 0.05 *T*-score points per year for Cohorts 2 and 3, respectively) were significantly more positive their control-group counterparts (-0.05 and -0.74 *T*-score points, respectively). There were no statistically significant differences between the TAKS mathematics outcomes for Cohort 1 post-immersion and control-group ninth graders. Still, the TAKS mathematics growth rates of economically advantaged and disadvantaged post-immersion ninth graders (0.53 and 0.41 *T*-score points per year, respectively) were steeper than the rates of their control-group counterparts (0.22 and 0.10 *T*-score points per year). For TAKS mathematics, the sizes of immersion effects in standard deviation units for Cohort 2 (.20) and Cohort 3 (.16) were small but statistically significant. The estimated immersion effect for Cohort 1, ninth graders in standard deviation units (0.13) was similar to the magnitude of the effect detected at the end of their eighth-grade year.

Similar to the previous year, students' use of their laptops for Home Learning—a measure of the extent to which a student used a laptop outside of school for homework in the four core-subject areas or for learning games—was the strongest implementation predictor of students' TAKS reading and mathematics scores. Given that the level of implementation of Technology Immersion varied from school to school, classroom to classroom, and student to student, we used a series of hierarchical linear models to investigate the relationships between implementation levels and student academic achievement. Specifically, Student Access and Use was an aggregate implementation measure of the extent to which a student had access to a laptop throughout the school year (number of days), the frequency of technology use for learning in core-subject classes, and the extent of laptop use for homework and learning games. Student-level HLM results showed that the composite measure of Student Access and Use was a consistently positive although not always statistically significant predictor of students' TAKS reading and mathematics scores for Cohorts 2 and 3. Of the three elements of Student Access and Use, students' use of their laptops for Home Learning—a measure of students' use of laptops outside of school for homework in core-subject areas and for learning games—was the strongest predictor of both TAKS reading and mathematics achievement across both cohorts.

For Cohort 2 (eighth graders), the extent of Home Learning was a positive but nonstatistically significant predictor of students' TAKS reading achievement and a positive and marginally significant predictor of TAKS mathematics achievement. For Cohort 3 (seventh graders), the extent of laptop use for Home Learning was a positive and statistically significant predictor of both TAKS reading and mathematics scores. In contrast, reading and mathematics teachers' reported levels of Classroom Immersion were inconsistent predictors of students' TAKS scores.

The findings for Home Learning underscore the important role that individual student laptops play in promoting ubiquitous learning and in equalizing the out-of-school learning opportunities for students in disadvantaged family and school situations (Burbules, 2007; Dede, 2007). Individual student laptops, in contrast to laptops on carts or computers available in libraries, labs, and classrooms, expand where and how student learning occurs. In a third-year implementation study of the traits of higher Technology Immersion schools and teachers, researchers found that students at higher Technology Immersion schools typically had access to laptops "24/7." Teachers at higher immersion schools encouraged students' use of laptops outside of school by engaging students in projects or assignments that motivated students to continue working outside of class. Also, access to electronic textbooks on laptops motivated many students to continue working on chapter assignments outside of school (Shapley et al., 2008).

Conclusions about the effects of Technology Immersion on TAKS social studies and science scores remain in doubt. However, outcomes for TAKS writing, which involved the administration of the TAKS assessment in traditional paper-and-pencil format, have consistently favored control students although not by statistically significant margins. Since TAKS tests for social studies, science, and writing are not administered annually, immersion effects for those subject areas cannot be replicated across cohorts and years. Accordingly, it is difficult to draw definitive conclusions about the effects of Technology Immersion for these subject areas. Available results have revealed no statistically significant differences between treatment and control groups for TAKS social studies, science, or writing scores. Treatment-control group differences for TAKS writing, however, have consistently favored students at control schools.

Social studies. The TAKS social studies test is administered for the first time in 8th grade, so students' 5th grade TAKS reading scores were used to adjust for prior achievement. After controlling for Cohort 2 eighth graders' reading achievement, demographic characteristics, and school poverty, there was no statistically significant effect of immersion on students' 2008 TAKS social studies scores. The immersion effect was virtually zero (0.006 *T*-score point).

Science. After controlling for prior achievement (5th grade science score), demographic characteristics, and school poverty, there was no statistically significant effect of immersion on Cohort 2 eighth graders' TAKS science achievement. The immersion effect was positive (0.48 *T*-score point) but not by a statistically significant margin.

Writing. After controlling for Cohort 3, seventh graders' pretest writing scores (4th grade writing score), demographic characteristics, and campus poverty, there was no statistically significant effect of immersion on students' 2008 TAKS writing scores. Similar to previous years, the immersion effect was negative (-0.73 *T*-score point). Across evaluation years, seventh graders in immersion schools, on average, have had consistently lower TAKS writing scores (-0.91, -0.28, and -0.73 *T*-score points for Cohorts 1, 2, and 3 seventh graders, respectively). It is possible that the administration of the TAKS assessment in paper-and-pencil format may underestimate the writing performance of Technology Immersion students who have used word processing software on a regular basis for written schoolwork. Some research studies have shown that traditional assessments underestimate the writing performance of students who are accustomed to using word processors for writing and are not allowed to use word processors when tested (Russell & Haney, 1997; Russell & Plati, 2001).

Nature of Fourth-Year Implementation

The section below describes the progress made by schools in implementing the Technology Immersion model across the second through fourth project years.

The overall level of implementation of the Technology Immersion model increased to some extent across years—even so, just a quarter of schools reached substantial levels of immersion by the end of the fourth implementation year. Full implementation of the Technology Immersion model requires support in several ways: Leadership, Teacher Support (buy-in), Parent and Community Support, Technical Support, and Professional Development. Given adequate supports, teachers are expected to reach high levels of Classroom Immersion, and Student Access and Use of technology is expected to be robust. Mean immersion standard scores revealed small yearly increases across most of the implementation support components (Leadership, Teacher Support, Parent/Community Support, and Professional Development) as well as increases in teachers' overall level of Classroom Immersion. In contrast, the level of Student Access and Use declined across years. Mean fourth-year immersion standard scores (ranging from 2.69 to 3.19 on a 4-point implementation scale) showed that many schools needed stronger supports, especially in the areas of parent and community support for technology use, technical supports that addressed obstacles to technology use, and professional development for teachers.

Core-subject teachers at the majority of schools reported only partial levels of Classroom Immersion in the fourth year. Teachers' mean scores at a fifth of schools, however, revealed substantial levels of Classroom Immersion. As a whole, the standards-based implementation scores for Classroom Immersion increased slightly across years (from 2.48 to 2.69 on a 4-point scale). Standard scores for four of the five elements of Classroom Immersion showed somewhat stronger implementation in the fourth year, with the largest increase for teachers' use of technology for their own purposes (Professional Productivity) and the smallest change for classroom integration (Technology Integration). The frequency with which teachers allowed students in their classrooms to use technology for learning activities (Student Activities) remained relatively stable across years.

Students' access to and use of laptops for learning within and outside of school continued to fall well short of expectations in the fourth year. The percentage of schools with at least *partial* levels of Student Access and Use decreased across three evaluation years (76%, 68%, and 57%), while the percentage of schools with *minimal* student access and use increased (24%, 32%, and 43%). Several factors affected students' opportunities to use their laptops for learning both within classrooms and outside of school. These factors mainly included time lost for repairs due to aging laptops, schools that opted to transfer laptops from individual students to carts or classroom sets, schools that restricted students' use of laptops outside of school, and teachers' preferences regarding classroom laptop use. Year-to-year comparisons showed that the mean implementation level for Laptop Access Days increased between the third-and-fourth implementation years (from 2.50 to 2.64 on a 4-point scale) due to more consistent student "access" to laptops (although not "ownership") at some schools on carts or as classroom sets. At the same time, the yearly mean implementation levels for laptop use for Core-Content Learning (classroom laptop use) decreased across years (2.07, 2.12, and 1.95) and the use of laptops for Home Learning, likewise, decreased over time (1.75, 1.84, and 1.63). This trend is consistent with what other researchers have documented. When teachers are the "gatekeepers" of students' technology use, many teachers, especially veterans, will opt to continue traditional practices and reject practices that require innovation and instructional change (Cuban, 2002; Russell, Bebell, & Higgins, 2004).

Implementation and Sustainability

Implementation Fidelity of the Technology Immersion Model

During spring 2008 site visits at schools, researchers asked principals, technology specialists, and teachers to describe their progress in implementing Technology Immersion, and in retrospect, what they would have done differently to improve implementation. Key findings from interviews and focus groups are summarized below.

Nearly all of the Technology Immersion Pilot (TIP) grantees said the lack of a start-up year for planning was a major barrier to effective implementation of Technology Immersion. The majority of middle schools received their TIP grant award just before the start of the first project year. Thus, many thought implementation would have progressed more smoothly if there had been a start-up year to plan for immersion. Various respondents said a planning year would have allowed them to (a) have conversations with teachers about the decision to become an "immersed school," (b) develop a plan for managing laptops (especially at larger campuses with as many as 1,500 laptops), (c) build the school's infrastructure for wireless technology, (d) have teachers become more accustomed to laptops and available software and digital resources, (e) provide professional development for teachers to strengthen their technical skills and ability to plan technology-integrated lessons, and (e) give teachers a chance to “try out” lessons with laptops in the classroom before students had their own laptops. One administrator said, “We flew by the seat of our pants…learning after the fact.” Other respondents said the lack of planning made the first implementation year “hectic” or “stressful.” Several grantees, however, described practical lessons that could only be learned through experiences with one-to-one computing.

TIP grantees who were more successful thought that committed leaders, thorough planning, teacher buy-in, preliminary professional development for teachers, and a commitment to the transformation of student learning were keys to their successful implementation of Technology Immersion. Respondents at middle schools that had been more successful attributed effective implementation to several factors. Foremost, despite a quick start, district and school administrators had a well-conceived plan for implementation, were excited about the project, and listened to teacher input. Administrators had “high expectations” for technology use but allowed time for teachers to become comfortable. One teacher explained:

> We had the right combination of encouragement and push…Leadership, encouragement, and push. It wasn’t punitive, it was positive…but they kept up the pressure…That constant, positive pressure moved me forward.

Professional development for teachers was a high priority. Training typically began before the first year started and was ongoing across implementation years. These schools also had collegial cultures. Teachers learned by “seeing what other teachers were doing and how they were implementing technology.” “We were all in this together,” explained one teacher, “Some teachers liked what they had always done, but we were willing and ready to try.” The improvement of students’ learning experiences was a driving force for higher quality implementation at these schools. Despite myriad laptop management issues, respondents believed the challenges had been worthwhile because one-to-one student laptops and digital resources had increased the depth of learning across subject areas, exposed students to more real-life experiences, and allowed students to demonstrate greater responsibility.

Many TIP grantees reported that administrative turnover, noncommittal teachers, insufficient professional development, inadequate school infrastructures, and laptop management problems were impediments to effective implementation of the Technology Immersion model. Respondents at many schools cited obstacles that had derailed their implementation efforts. At many schools, constant principal turnover caused major set-backs each year and undermined teacher buy-in for immersion. Many teachers expressed noncommittal attitudes about the continuation of Technology Immersion at their schools, which seemed to stem from four main sources: (a) frustrations caused by the concurrent distribution of laptops to teachers and students in the first year, (b) the insufficiency of their preparation to meet technical demands and manage technology-integrated lessons, (c) students’ inconsistent access to laptops for classroom activities, and (d) uncertainty about their students’ capacity to handle one-to-one laptop access (i.e., students were too young or immature, lacked sufficient technical and keyboarding skills, had insufficient prior experience with computers, behaved irresponsibly with expensive laptops, or wanted to use technology to “play” rather than “learn”). One administrator summed it up by saying, the “success of Technology Immersion depends on the teacher—some are hesitant.” Many teachers wished that professional development had been provided earlier, and that the training received had focused on content-specific lesson plans. Many teachers new to schools felt unprepared to deal with laptops in classrooms. Additionally, respondents at these schools often cited problems with inconsistent wireless Internet services, insufficient technical staff to deal with laptop repairs in a timely manner, and students who did not bring their laptops to school or class regularly.

A qualitative report—*Third-Year (2006-07) Traits of Higher Technology Immersion Schools and Teachers*—provides a comprehensive examination of implementation successes and challenges at Technology Immersion schools (Shapley et al., 2008).

Sustainability of the Technology Immersion Model

As part of site visits, administrators, technology specialists, and teachers also commented on sustainability of the Technology Immersion model at their schools. Key findings are summarized below.

Sustainability depended on the commitment of district leaders to Technology Immersion and to long-range planning for continuation. The principals and technology specialists at many campuses had not been directly involved in planning for the sustainability of Technology Immersion beyond the fourth year, and in fact, most said that decisions about continuation would rest with district administrators. In other cases, plans were in place to continue Technology Immersion at middle schools, and some districts were planning to expand one-to-one computing to high schools or upper elementary grades. Respondents who described explicit plans for continuation cited the key role of the superintendent and board of trustees. "If your district and school board are committed to it, it is sustainable," said one respondent. Sustainability of Technology Immersion rested on planning ahead and being prepared for future years, including actions such as (a) having a plan for the replacement of worn and outdated laptops (b) allocating resources to support continuous teacher professional development, and (c) allocating resources for technical support and student Help Desk facilities. Some administrators said a plan for a three-year replacement cycle for laptops was essential.

Sustainability of Technology Immersion depended on the adequacy of funds to support continuation. With grant funds ending, many campuses were uncertain about how Technology Immersion could be sustained financially. Given limited local and state dollars for technology, most respondents described their hopes for winning additional grant awards to continue their one-to-one laptop programs. For example, some administrators hoped to receive funding from the Bill & Melinda Gates Foundation, Vision 20/20 grants, STAR grants, or U.S. Department of Agriculture funds for rural school districts. Many principals were optimistic about their chances of securing grants to support continuation but had doubts about receiving financial support from their districts or the state. A few districts and schools, however, had used local funds to support Technology Immersion. For example, one district decided to eliminate computer labs and apply the money toward individual laptops, some districts were considering lease/purchase options for laptops, one school planned to use their district technology allotment to purchase laptops, and other schools were planning to use technology funds to purchase laptop parts and supplies to keep worn laptops up and running for another school year. A charter school had a generous business partner, an enthusiastic supporter of the Technology Immersion concept, who was studying how one-to-one laptop access for students could be continued at more modest costs. An administrator in one district said continuation of Technology Immersion depended on a local bond issue. If the bond failed, there would be no money for laptops at the school. In this district, budget shortfalls were causing cuts to administrative and teaching positions, so there was little hope of receiving district money for technology.

A superintendent who was interviewed explained the importance of having dedicated local funds to sustain a one-to-one project: "It started with the TIP grant, but it is a vision of ours, we are committed to it. We committed to it locally and committed a ton of resources outside of the grant." Although this district was trying to use local funds to support the project, the superintendent believed the state should provide more or more flexible financial support. In particular, state funding allocations earmarked by lawmakers for specific programs prevented local education agencies from combining state and local funds for school-reform initiatives, which local educators believed had greater potential for improving students' academic performance. Additionally, several respondents thought the state should provide additional technology funding so that schools did not have to depend entirely on local funds. Having sufficient local funds for technology was an acute problem for a property-poor district that depended on state funds and grants to purchase technology, but frequently did not qualify for grants because the district maintained high TAKS test scores. One respondent said the continuation of Technology Immersion simply "depended on how much money the state legislature makes available to schools." A few administrators believed traditional paper textbooks are outmoded and state funds invested in printing and delivering millions of textbooks across the state should be used to fund technology.

For other campuses, it seemed that the TIP project was just another grant program, and once funding ended, the TIP project would disappear. One principal said, "Unless we come up with another source of funding for equipment and software, technology will be cut." Other principals said they would "love to continue immersion" but saw no way to financially sustain the current model. One principal said, Technology Immersion is only sustainable in an "ideal world." Another administrator said, "If the grant is not renewed, it would be the end of one-to-one computing."

Sustainability of Technology Immersion was associated with educators' beliefs about technology's value for addressing the learning styles and needs of students, and educators' commitment to move toward digital school environments. School leaders who wanted to continue one-to-one laptop projects often linked their intentions with hopes for student learning. Administrators cited goals that involved moving students "away from drill and practice" and toward "creation of products;" preparing students for the 21st century by building literacy, problem solving, and collaborative skills; expanding learning outside of school; exposing students to "worldwide cultures" so they have a sense of being part of a larger community; and making learning "more than regurgitating information back on a test." In describing the major accomplishments of Technology Immersion, a committed administrator said:

> We have impacted a ton of kids in a positive way. It has impacted their learning; it has impacted their exposure to the world; it has impacted their education experience; it has impacted them personally, and by that I mean their self-esteem, the way they feel about themselves and the way they feel about education; it has made a huge difference.

Other campuses were committed to the continuation of Technology Immersion because superintendents saw the value of going "paperless." This involved purchasing electronic versions of textbooks (on CDs or online) instead of traditional paper copies, and conducting student assessments online. Some spoke of the value of online college coursework for students, virtual learning opportunities, and reduced costs for small, rural school districts through shared teachers for coursework delivered via videoconferencing. Some administrators said they simply could not "imagine being without laptops." They had seen such growth in the use of software applications for purposes such as TAKS preparation that it would be difficult to be without laptops. "We would be stepping back in time," said one administrator who believed laptops played a critical role in preparing students for college where they "will be required to do everything with technology."

Some school administrators were committed to continuation of Technology Immersion, but they wondered if an incremental approach to implementation might have improved their long-term prospects for sustainability. Some principals, especially those at larger schools, believed it might be easier to move toward full implementation of the Technology Immersion model by introducing student laptops gradually, immersing one grade at a time. One principal said, "I would phase it in grade by grade, so that it would be done by groups of teachers and students." Another respondent argued for a three-year immersion cycle for middle-school grades, with the cycle tied to the replacement of worn laptops. Some teachers thought a gradual approach to introducing laptops during the school year would help. For example, laptops could initially be used as class sets (i.e., for the first six weeks) until students became acquainted with laptops and the guidelines for appropriate care. Nevertheless, one administrator explained why the ultimate goal should be school-wide implementation of the Technology Immersion model:

> The full immersion model was the best way to go…because we are all on the same page. It is a campus initiative. So the conversations are not just horizontal, it is vertical as well. That's the power of it…And the electives, it is across the board a whole-campus initiative.

At the end of TIP grants, several schools that had experienced great difficulty implementing the Technology Immersion model were planning to abandon one-to-one student laptop access and return to more conventional configurations of educational technology. Some schools that had experienced severe problems implementing the Technology Immersion model were considering other options to continue student access to technology at their schools. Several respondents described these kinds of changes: (a) one-to-one computing would be sustained only at selected grade levels, (b) student access to laptops would be restricted to in-school use only, (c) laptops would be distributed as classroom sets, or (d) laptops would be placed on mobile carts for teacher checkout. A number of teachers expressed preferences for having classroom sets of laptops instead of individual student laptops. These teachers believed classroom sets would minimize laptop "wear and tear" and also "ensure that all students have a laptop" in class. Although some principals thought the TIP project had been successful, changes reflected concerns about the adequacy of financial and personnel resources to sustain one-to-one computing at their schools. Decisions to move toward more traditional technology configurations were typically intended to prolong the life of laptops.

Findings from four evaluation years suggest that Technology Immersion can be implemented and is sustainable if districts and schools are committed to the model—however, other approaches to technology use may be appropriate for some districts and schools. Over four years, it became evident that Technology Immersion involved more than just buying laptops for students. Technology Immersion is a comprehensive model for transforming the school culture, and the nature of teaching and learning, and expanding the educational boundaries of the school. This study has shown that fundamental school change is difficult and requires a long-term commitment at all levels of the school system (board members, superintendent, principals, teachers, students, and parents). Given the challenges of implementing and sustaining the Technology Immersion model, statewide implementation may not be possible. However, those districts and schools that are committed to Technology Immersion should have state support for their innovative school-reform efforts; at the same time, other districts and schools should receive support for alternative technology-based initiatives that have research-based evidence of effectiveness.

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Appendix A
Theoretical Framework for Technology Immersion—Literature Review

The theoretical framework (Figure 1.1) guides the evaluation. The research literature underpinning the Technology Immersion model and the theoretical framework is provided in sections to follow. In some cases, sources relate specifically to educational technology, whereas in other instances, evidence comes from studies of education in general. Research evidence for some variables is relatively robust; in other areas, evidence is weaker. Although research on one-to-one computing initiatives has grown in recent years, there are still few experimental studies or studies with well matched comparison groups that provide evidence of causal effects.

Technology Immersion Model

The Technology Immersion model assumes that effective technology use in schools and classrooms requires robust technology access, technical and pedagogical support for implementation, professional development for educators in using technology effectively, and readily available curricular and assessment resources that support the state's foundation curriculum (English language arts, mathematics, science, and social studies).

First, technology use in schools and classrooms requires *robust access*. Despite school-level improvements in the ratio of students to instructional computers in Texas (Education Week, 2007), recent survey data show that an average of 2.9 or less classroom computers is insufficient to allow every student access (Shapley, Benner, Heikes, & Pieper, 2002; Shapley et al., 2006). In response to prevailing conditions, Technology Immersion calls for one-to-one student access to computers. The Texas project, in contrast to one-to-one laptop initiatives being implemented in other states and school districts (e.g., Maine, Michigan, New Hampshire, Vermont, Henrico County in Virginia) adopts a comprehensive approach. In particular, Technology Immersion assumes that increased access to and use of technology in schools requires adequate *technical and pedagogical support*. Schools must have robust electronic networks to support wireless laptops and digital content. Campus-based support is also vital, as ample studies show the importance of on-site support personnel who assist teachers in learning to use technology, troubleshooting technical problems, and effectively integrating technology into lessons (e.g., National Center for Education Statistics [NCES], 2000; Ringstaff & Kelley, 2002; Ronnkvist, Dexter, & Anderson, 2000; Shapley et al., 2002).

In addition, the Technology Immersion model assumes that teachers must have effective *professional development.* High-quality professional development, as research demonstrates, is of longer duration and provides richer learning experiences, more comprehensive investigation of topics, and time for practice and experimentation (e.g., Garet, Porter, Desimone, Birman, & Yoon, 2001; Lawless & Pellegrino, 2007; Penuel, Fishman, Yamaguchi, & Gallagher, 2007; Smerdon, et al., 2000). Moreover, when a particular technology is mastered over time, it is more likely to be incorporated into instruction (Zhao & Frank, 2003). Teachers also need follow-up support as they acquire and implement new skills in the instructional setting (Bradburn & Osborne, 2007; Garet et al., 2001; Nugent & Fox, 2007; Sulla, 1999). Professional development should also focus on subject-specific content or specific teaching methods. For technology, this means building teachers' basic technology skills as well as their understanding of curricular integration (CEO Forum, 2000, 2001; Denton, Davis, & Strader, 2001; Ringstaff & Kelly, 2002; Web-Based Education Commission, 2000). The alignment of professional development activities with teachers' personal goals for learning is also important in advancing teacher change (Garet et al., 2001; Penuel et al., 2007).

Additionally, technology-related professional development should be part of broader professional growth initiatives in schools (Fullan & Hargreaves, 1996; Mann, Shakeshaft, Becker, & Kottkamp, 1999; Newmann & Associates, 1996). Professional development activities that include collective participation (e.g., whole schools or teachers of the same subjects or grades) are more likely to be coherent with teachers' experiences and needs (Garet et al., 2001). A leadership development component is crucial because research points consistently to the important role of school leaders in successful implementation of technology (Bradburn & Osborne, 2007; Johnston & Cooley, 2001; Pitler, 2005).

Technology Immersion also requires *curricular and assessment resources* that support the state's curriculum. Thus, laptops in immersion schools include software that allows students and educators to use wireless laptops as a tool for teaching, learning, communication, and productivity. Digital resources (e.g., online, CD-ROMS, stored on local networks) also provide students with a means for more personalized learning activities, and interactive technologies allow them to build new knowledge by doing, receiving feedback, and refining their understanding. Technologies also help students to acquire more information, visualize difficult-to-understand concepts, and advance understanding (Bransford, Brown, & Cocking, 2003). Online formative assessments enable teachers to diagnose students' strengths and needs or to assess their mastery of curricular standards.

Theoretical Framework: School-Level Variables

In a "technology immersed" school, technology resources are ingrained in the school's organizational and cultural environment. Technology immersion, therefore, should change not just classroom instruction and learning, but also the nature of interactions between student and teacher, teacher and teacher, teacher and principal, and the school within the surrounding community (Dwyer, 1994). Considering the systemic nature of technology immersion, the evaluation examines factors that help to explain how and under what conditions technology affects students' learning opportunities and academic achievement. The sections below describe the key variables of interest at the school level, including leadership, innovative culture, parent and community support, and technical support.

Leadership

Over the past several decades, researchers have concluded consistently that school leadership is critical in developing and maintaining conditions that support school change and academic improvement (e.g., Hallinger & Heck, 1996 cited in Spillane, 2003; Leithwood, Seashore, Anderson, & Wahlstrom, 2004). Similarly, administrative support is a major factor that influences technology integration (International Society for Technology in Education, 2002; Bradburn & Osborne, 2007). Leaders in a technology-enhanced environment must be "champions of technology, teaching, learning, and students" (Johnston and Cooley, 2000, p. 95). The principal, in particular, is a pivotal figure in effective technology implementation. The visionary principal is one who sees the integral relationship between technology and education, and marshals resources to help teachers master effective practices (Tinucci, 2000). Additionally, effective principals are "transformational leaders" who create more collaborative teaching and learning environments through their facilitation of opportunities for technology specialists and teachers to share their knowledge, experiences, and insights (Bradburn & Osborne, 2007).

A consistent vision and plan for change is also essential for whole-school reform efforts such as technology immersion. Shared vision, or buy-in, moves schools toward substantive changes in instructional approaches and improved student outcomes (Leithwood et al., 2004). Conversely, without broad-based support, technology immersion may be untapped resource that has little impact on student learning (Cradler, 1992; Means & Olson, 1994).

Innovative Culture

The school culture may either promote or impede whole-school initiatives such as technology immersion. When undertaking innovation, the organization's shared commitment to change and ability to build capacity for doing things in a new way are important (Senge, 1999). In education, some schools are more successful than others in enacting and sustaining innovation, and in more effective schools, changed practice is a collective rather than an individual enterprise (Fullan, 1993). Similarly, movement towards new ways of teaching and learning with technology is more significant if teachers are able to work collaboratively (Chapman, 1996). Shared professional learning opportunities provide a viable means to stimulate innovative teaching practices (Birman, Desimone, Porter, & Garet, 2000; Dibbon, 2003). Considering prior research, we believe that educators' collective experiences at immersion campuses will advance their shared understanding of technology's use and encourage integration efforts. Schools that begin the project with more collaborative cultures may advance at a faster pace (Fullan, 1999).

Parent and Community Support

The local community also may influence technology immersion. Its constituents consist of parents, neighborhood residents, local professionals, and elected school board officials. Educating and involving the community has been identified as a key component in ensuring successful change in educational practices (Desimone, 2002; Goertz, Floden, & O'Day, 1996; Leithwood et al., 2004). If parents and community members are "on the same page" as the school with regard to technology immersion, they can contribute the kind of supports and resources required for changes in educational practices. At immersion campuses, community outreach may take many forms, such as participation on a technology committee, attendance at informational sessions or workshops, the dissemination of information through district and campus websites, or media releases to spread the word about technology immersion. Most important, in a one-to-one computing project, parents must be partners in assuming responsibility for the appropriate use of laptops outside of the school.

Technical Support

Texas has strongly supported the infusion of technology into its schools (Texas Education Agency, 2002; 2006). Consequently, at the start of this project, both treatment and control campuses had existing inventories of technology hardware, software, and educational programs. Districts and campuses also had human resources such as technology coordinators and technical support personnel who supported technology at the district and campus levels. Given existing contextual conditions, and the infusion of resources through technology immersion, an examination of the nature and quality of technical support at participating schools is important.

Theoretical Framework:Teacher Variables

At the teacher level, we theorize that technology immersion leads to increased technology proficiency, greater use of technology for professional productivity, more frequent opportunities for students to use technology in classrooms, and pedagogical changes such as increased technology integration and more learner-centered instruction. New technology also is expected to advance the intellectual demands of lessons and assignments. Moreover, teachers in schools that are immersed in technology should begin to collaborate more often with their peers as they experiment with new instructional technologies and digital resources.

Technology Proficiency

A number of studies associate teachers' technology proficiencies with technology implementation. Research indicates that teachers need a solid foundation of technology literacy before they can successfully integrate technology into the curriculum. Teachers must learn to use technology comfortably and efficiently (Dusick, 1998-1999; Goldsworthy, 2000). Studies also show that teachers with stronger computer skills use technology in a greater number of ways and on a more regular basis, and these teachers are more likely to increase their technology-use frequency over time (Ronnkvist, Dexter, & Anderson, 2000). Moreover, teachers with the strongest technology proficiencies use technology in more innovative ways in their content areas (Becker, 2000).

Unfortunately, research indicates that many teachers lack the proficiencies and understanding necessary to apply technology resources to instruction and learning effectively. A national study found that more than half of teachers felt only somewhat prepared to use technology for instruction, and more experienced teachers felt less prepared than their more novice counterparts (Smerdon et al., 2000). Surveys of Texas teachers have revealed improvements in proficiencies across time, but teachers' proficiency levels remained below targeted standards (Shapley, Benner, Heikes, & Pieper, 2002). Similarly, 2005-06 statewide outcomes for the Texas Teacher STaR Chart (a measure of teachers' technology readiness) showed that nearly three of four Texas teachers rated their progress relative to the Teaching and Learning area as either Early Tech (14.7%) or Developing Tech (55.6%). Only one in four teachers believed they had attained proficiencies designated as Advanced Tech (23.7%) or Targeted Tech (5.8%) (Texas Region 10 Education Service Center & Texas Education Agency, 2006).

Professional Productivity

Skilled teachers also are more likely to use technology as a tool to enhance their own professional productivity, including actions such as communicating with students and parents by email, creating electronic lesson plans, or accessing information from the Internet for lessons (Shapley et al., 2002). Researchers typically have not investigated teachers' use of technology for professional productivity, but it is important in Texas because state standards call for teachers to use technology for communicating effectively, as well as for acquiring, analyzing, and evaluating a variety of electronic information. In an immersed school, teachers are expected to increasingly communicate by email, report attendance and submit lesson plans electronically, post information on a class or campus website, and analyze and interpret electronic data from assessments.

Classroom Technology Use

The link between increased technology access and increased classroom use is well documented. Teachers use computers and the Internet more often when technologies are available in their classrooms rather than in other locations in the school (Becker, 2001; Smerdon et al., 2000). Teachers involved in Maine's one-to-one initiative, in fact, used technology more often, possessed a broad knowledge of technology resources, and made progress in incorporating technology into practice (MEPRI, 2004). Thus, we assume that providing laptops for each student in an immersed school will increase students' opportunities for classroom technology use.

Technology Integration and Learner-Centered Instruction

Abundant technology hardware and software is important, but if those resources are not well integrated into instructional approaches and learning experiences, the impact on student achievement may be negligible. Notably, studies show that teachers' ideologies affect the likelihood of technology integration, with teachers' perceived costs and benefits influencing changed practices (Zhao & Frank, 2003). Research also suggests that teachers' understanding of new learning theories and understanding of how technology supports enriched learning opportunities are important (Bransford, Brown, & Cocking, 2003; Johnston & Cooley, 2001). Researchers studying the Apple Classrooms of Tomorrow (ACOT) found that abundant access to classroom technology changed teachers' beliefs as well as their instructional approach. Teachers' beliefs and practices evolved along a technology integration continuum that gradually led to effective instructional practices. Movement from the *entry* phase to *invention* (technology-intensive environments) required time and ongoing support (Dwyer, Ringstaff, & Sandholtz, 1991).

Specifically, researchers found that ACOT teachers began to incorporate more collaborative work and fewer teacher-centered, lecture-oriented lessons in favor of student-centered ones (Baker, Gearhart, & Herman, 1994). Subsequent studies, likewise, have found evidence of teachers adjusting their pedagogical style, with students taking more responsibility for their own learning in one-to-one laptop classrooms (MEPRI, 2003), and classroom structures that shifted from large group to students working independently or to more student-centered activities (Rockman ET AL., 1998; Russell, Bebell, Cowan, & Corbelli, 2002). Other evidence, however, suggests that some teachers view technology as an add-on or reward for students who finish their seatwork rather than an integral part of their pedagogical repertoire (Rockman ET AL., 1998).

Intellectual Challenge

Technology immersion's main benefit may stem from opportunities for more complex modes of teaching and learning. Research on technology-infused classrooms reveals positive attributes, such as the ability to bring real-life problems into the classroom or high-quality simulations of them. Technology also allows teachers to model thinking strategies and allows individual learners to approach tasks in different ways using different learning strategies (Goldman, Cole, & Syer, 1999; Many, Fyfe, Lewis, & Mitchell, 1996; Sulla, 1999; Temple & Rodero, 1995). This view of technology's potential for more advanced learning contrasts with evidence on prevailing classroom conditions. While three-quarters of teachers nationally report using computers or the Internet for instruction, most lessons fail to involve complex inquiries, explorations, or problem-solving activities (Doherty & Orlofsky, 2001). Similarly, Texas students and teachers use technology mainly at a basic level, with technology used most often for tasks such as conducting Internet research on an assigned topic (Shapley et al., 2002).

Collaboration

Research suggests that teachers need time to discuss technology use with other teachers. Professional collaboration includes communicating with educators in similar situations and with teachers who have previous technology experiences. Collaboration may occur in face-to-face meetings or through technology venues such as email or videoconferencing. Teachers in the Maine laptop initiative, for example, believed their most effective professional development activity was informal help from colleagues. E-mail, listservs, and websites enabled Maine teachers to exchange information and stay in touch with their peers (MEPRI, 2003). Moreover, Zhao and Frank report that "teachers who perceived pressure from colleagues were more likely to use computers for their own purposes, and teachers who received help from colleagues were more likely to use computers with their students" (2003, p. 825).

Theoretical Framework: Student Variables

Over the past decade, a growing body of research points to positive effects of technology on students' skills, learning, and achievement. In the research literature, evidence suggests that technology access fosters positive student effects for technology use, technical proficiencies, motivation and engagement, intellectually challenging schoolwork, self-direction, and to a lesser extent, academic achievement.

Technology Use

Technology is used more often for instructional and learning purposes in one-to-one laptop classrooms (Russell, Bebell, & Higgins, n.d.). Additionally, students involved in ubiquitous technology initiatives use technology more often outside of school. Russell et al. (n.d.) found that students in one-to-one classrooms used computers at home more frequently for academic purposes. Likewise, other researchers found that students spent less time watching television and more time on homework after they received laptop computers (Baldwin, 1999). Moreover, laptops provided a means of “closing the digital divide” between more advantaged students who had access to computers and the Internet at home and those without technology outside of school (Rockman, 2003).

Technology Proficiency

Students’ technology proficiencies reportedly increase with ubiquitous technology. Laptop students in one study considered themselves more proficient users of Word, Excel, PowerPoint, the Internet, email, and CD-ROMS than non-laptop students (Rockman ET AL., 1998). Similarly, fifth and sixth graders who received laptop computers in another study reported increased computer skills and better Internet research capabilities (Lowther, Ross, & Morrison, 2001). In another study, German high school students with laptops made greater gains than comparison students on measures of technology literacy, such as knowledge of hardware and the operating system, productivity tools, and Internet use (Schaumburg, 2001).

Motivation and Engagement

Numerous studies report links between one-to-one technology and increased student engagement (MEPRI, 2003; Rockman ET AL., 1998; Russell et al., n.d.; Woodul, Vitale, & Scott, 2000). The five-year ACOT evaluation established a link between technology use and student attitudes. Students voluntarily used time outside of school to work on technology-based projects, and they often initiated their own computer-related projects (Baker, Gearhart, & Herman, 1994). Students involved in the Maine Learning Technology Initiative, similarly, found school and learning more interesting and preferred using laptops for most school-related tasks (MEPRI, 2003).

Additionally, studies have examined the relationship between technology and student behavior. In a statewide study in Florida, middle schools experienced fewer student conduct violations and disciplinary actions as the number of computers in use per student increased (Barron, Hogarty, Kromery, & Lenkway, 1999). Other studies, likewise, report decreased discipline problems associated with one-to-one computing (Baldwin, 1999; MEPRI, 2003). In another study, a computerized curriculum positively affected the psychosocial and academic outcomes of students identified as chronically disruptive (Aeby, Powell, & Carpenter-Aeby, 1999-2000).

An evaluation of the North Carolina Laptop Notebook Project revealed a strong correlation between computer use and improved school attendance. Students participating in the laptop program had fewer absences and late arrivals as compared to non-participants (Stevenson, 1998). In Henrico County Public Schools in Virginia, preliminary evidence linked increased student motivation, engagement, and interest to one-to-one computing (Zucker & McGee, 2005).

Intellectual Work

Existing studies suggest that student technology use most commonly involves productivity tools, Internet research, and drill and practice activities. Activities involving higher-order thinking and peer collaboration, such as technology-based projects, multimedia authoring, problem solving with spreadsheets or databases, or correspondence with experts, are less common (Becker, 1999, 2001; Denton, Davis, & Strader, 2001; Smerdon et al., 2000). Contrary to prevalent practice, some believe that technology, at its best, can “facilitate deep exploration and integration of information, high-level thinking, and profound engagement by allowing students to design, explore, experiment, access information, and model complex phenomena” (Goldman et al., 1999). Additionally, technology allows students increased access to and use of a wide range of information, facilitating greater inquiry and investigation, exposure to places and resources beyond the classroom, and development of a stronger knowledge base (CEO Forum, 2001; Johnston & Cooley, 2001).

New circumstances and opportunities—not technology on its own—can impact student achievement. Several studies have established tentative links between interactive technologies and higher level reasoning and problem solving (Baker et al., 1994; Hopson, Simms, & Knezek, 2002). New technologies, apparently, allow students to build knowledge by doing, receiving feedback, and continually refining their understanding (Barron et al., 1999; Bereiter & Scardamalia, 1993). Technology also provides a medium for bringing real-world problems into the classroom for students to explore and solve. Students involved in the Jasper Woodbury Problem Solving Series, for example, had positive gains in mathematical problem solving, communication abilities, and attitudes toward mathematics (e.g., Cognition and Technology Group at Vanderbilt, 1997).

Self-Directed Learning

Several studies associate technology use with increased student self-directed learning. The connection assumes that working one-to-one with technology allows students to have hands-on, self-directed experiences since they work independently much of the time. The theory of self-regulation posits that a learner who knows how to be self-directed and independent will be more successful than one who is highly dependent on structured guidance (Zimmerman, 1989). The teacher’s role is to scaffold learning by making thinking processes more tangible and by modeling learning strategies (Bolhuis, 1996; Corno, 1992; Leal, 1993). Since self-directed learners are responsible owners and managers of their own learning process, control shifts over time from teachers to learners (Garrison, 1997).

Self-regulated or self-directed strategies enable learners to solve problems in new domains (Ertmer & Newby, 1996; Morrow, Sharkey, & Firestone, 1993) or to solve real-world problems (Bolhuis, 1996; Temple & Rodero, 1995). For example, in computer-supported science classes, middle-school students took more responsibility for their learning, and concurrently, displayed greater competence in complex problem-solving strategies (Raghavan, Sartoris, & Glaser, 1997). Another study suggested that students who learned in a self-directed environment were more productive. When writers were allowed to choose their own topics, they wrote more often and they wrote longer pieces (Morrow et al., 1993).

Academic Achievement

The ultimate goal of technology immersion is increasing the academic progress of students. Available evidence on the effects of laptops on student achievement comes from a few studies that have made comparisons between student groups with and without technology. Findings, although limited, have generally been positive.

The strongest evidence on the effects of laptops on achievement is in the area of writing. Lowther, Ross, and Morrison (2001, 2003) reported highly significant effects favoring sixth- and seventh-grade students with laptops over control students for dimensions of writing, such as ideas and content, organization, and style. In a less methodologically rigorous study, Rockman ET AL. (1999) found that laptop students outscored non-laptop students on four measures of writing, including content; organization; language, voice, and style; and mechanics, conventions, and presentation.

Some studies also have reported positive effects of one-to-one laptop access on students higher order problem solving (Lowther et al., 2003). Evaluation of a laptop project in Beaufort County, West Virginia, which focused on outcomes measured by a nationally standardized achievement test, found that laptop students participating in the program for two years had higher language, reading, and mathematics scores than non-laptop students (Stevenson, 1998). However, since there was no statistical control for prior achievement, findings are in doubt. Certainly, additional research studies with experimental designs are needed to draw definitive conclusions about the effects of one-to-one initiatives on student achievement.

Appendix B
Characteristics of Participating Schools

The schools participating in the study are compared in Table B.1. The distribution of middle schools across campus and district enrollment categories 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 B.1. Campus and District Enrollment by Comparison Group

	Immersion *N*=21		Control *N*=21	
Number of students	Number	Percent	Number	Percent
Campus				
300 or less	12	57.1	12	57.1
301-600	5	23.8	4	19.0
601 or more	4	19.0	5	23.8
District				
999 or less	8	38.1	8	38.1
1,000-2,999	6	28.6	5	23.8
3,000-9,999	0	0.0	0	0.0
10,000 or more	7	33.3	8	38.1

Note. Two campuses (one experimental and one control) were excluded from the comparison groups in the second year.

Tables B.2 and B.3 provide campus-level data for each of the 42 schools included in the study. Again, data 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, over a third of 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 B.2. Characteristics of Technology Immersion and Matched Control Schools

	Location			Students							
Campus	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
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				**375**	**31.2**	**5.9**	**62.2**	**13.5**	**14.7**	**70.8**	**15.8**

(*Continued*)

Table B.3. Characteristics of Technology Immersion and Matched Control Schools (*Continued*)

	Location			Students							
Campus	District	District Enroll-ment	Community Type[a]	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
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				**429**	**40.1**	**7.5**	**53.5**	**6.3**	**15.8**	**62.8**	**16.3**
Immersion school means				**375**	**31.2**	**5.9**	**62.2**	**13.5**	**14.7**	**70.8**	**15.8**
Overall school means				**402**	**35.7**	**6.7**	**57.8**	**9.9**	**15.3**	**66.8**	**16.1**

Source: Texas Education Agency AEIS reports 2004.
Note. Two campuses (one experimental and one control) were excluded from the groups in the second year.
[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).

Appendix C
Survey Items and Scale Reliabilities

Table C.1. Items and Reliabilities for School-Level Scales

Scale/ Item	Cronbach's Alpha Fall 2004	Spring. 2005	Spring 2006	Spring 2007	Spring 2008
Leadership and System Support	0.91	0.92	0.94	0.97	0.94
The principal consults with staff before making decisions about instructional technology that affect us.					
In this school, there are clear expectations that technology will be used to enhance student learning.					
The principal in my school actively encourages teachers to pursue professional development geared towards curricular integration of technology.					
Our school has a well-developed technology plan that guides all technology integration efforts.					
The principal is an effective leader for instructional technology in this school.					
Overall, considering the uses of technology in my school today, I am confident that this use is leading to increased student achievement.					
The principal encourages teachers to be innovative and try new methods.					
The principal is willing to support through funding or manpower teachers' efforts at technology integration.					
Administrators in this school help teachers to use technology to access, analyze, and interpret student performance data.					
Teachers receive adequate administrative support to integrate technology into classroom practice.					
Teachers and administrators rely on research-proven teaching and learning principles in making decisions about technology use.					
When our school has professional development focused on technology, the principal often participates.					
Classroom Technology Integration	0.67	0.68	0.76	0.75	0.71
Students have adequate access to technology resources in my classroom (e.g., digital cameras, scanners, projectors).					
I incorporate the TEKS for student technology applications into my content-area lessons.					
I have received sufficient training to incorporate technology into my instruction.					
I use technology to assess student performance and plan instruction.					
Technical Support	0.71	0.71	0.66	0.67	0.68
Most of our school computers are kept in good working condition.					
Internet connections in my class are often too slow or not working.					
My requests for technical assistance are addressed in a timely manner.					
Materials (e.g., software, printer supplies) for classroom use of computers are readily available in my school.					
Problems such as computers freezing or an inability to access the Internet make it difficult for me to use technology.					
Innovative Culture	0.78	0.79	0.82	0.82	0.82
Teachers in this school share an understanding about how technology will be used to enhance learning.					
Teachers in this school are continually learning and seeking new ideas.					
Teachers are not afraid to learn about new technologies and use them with their class(es).					
Teachers in this school are generally supportive of technology integration efforts.					
Parent and Community Support	0.78	0.79	0.85	0.84	0.84
Parents support our school's emphasis on technology.					
The surrounding community actively supports our instructional efforts with technology.					

Table C.2 Items and Reliabilities for Teacher-Level Scales

Scale/ Item	Cronbach's Alpha				
	Fall 2004	Spring 2005	Spring 2006	Spring 2007	Spring 2008
Technology Proficiency: I am confident that I can…	0.97	0.97	0.97	0.97	0.96
Send email to coworkers, parents, or peers.					
Collaborate through subscribing to a discussion list.					
Create an address book to send email to several people at once.					
Send a document as an attachment to an email message.					
Use a variety of search strategies, including key word and Boolean logic to find Web pages related to my subject matter interests.					
Search for and find a Web site with information about the Alamo.					
Create my own World Wide Web home page.					
Keep track of Web sites I have visited so that I can return to them later. (An example is using bookmarks.)					
Find primary sources of information on the Internet that I can use in my teaching.					
Use a spreadsheet (e.g., excel) to enter and calculate numbers.					
Use a spreadsheet to create a pie chart.					
Create a newsletter using desktop publishing techniques, including graphics & text in 3 columns.					
Perform basic software application functions such as opening an application program and creating, modifying, printing, and saving documents.					
Plan, create, and edit documents using word processing software (e.g., Word).					
Use the computer to create a slideshow presentation (e.g., Powerpoint).					
Plan, create, and edit databases using database software (e.g., Access).					
Use a database to search for and sort information and create reports.					
Use graphic organizers and/or systems thinking software (Inspiration, Stella, etc.) to teach concepts.					
Use drawing or painting software (e.g., Paint, Illustrator) to create pictures.					
Create a lesson or unit that incorporates subject matter software as an integral part.					
Use technology to collaborate with other colleagues who are distant from my classroom.					
Describe 5 software programs that I would select and use in my teaching.					
Write a plan with a budget to buy technology for my classroom.					
Teach my students about copyright issues as they relate to the Internet including citing sources.					
Take photos with a digital camera, save in a digitized format, and use in an electronic document.					
Scan images from a print source such as a book, save them in a digitized format, and use them in an electronic document.					
Create products incorporating text, audio, video, and graphics using multimedia authoring programs (e.g., Authorware, Hyperstudio).					
Professional Productivity: As a teacher, I…	0.93	0.94	0.94	0.91	0.92
Keep administrative records (e.g., attendance).					
Manage student assessment data (e.g., electronic gradebooks).					
Use technology to analyze and interpret student data to guide instruction.					
Create electronic lesson plans.					
Communicate with students.					
Communicate with parents.					
Communicate with colleagues/other professionals.					
Create instructional materials (e.g., tests, handouts).					
Gather information from the internet to create a lesson (e.g., text, video, clipart).					
Access model lesson plans integrating technology.					
Deliver information using presentation software (e.g., Powerpoint).					
Deliver information using multimedia presentations (text, audio, video, grgraphics).					
Post homework, class requirements, or project information on a website.					
Administer a formative assessment using Texas Mathematics Diagnostic System.					
Administer other online assessments.					
Use the internet at home for instructional purposes.					
Use a computer to do schoolwork at home.					
Students' Technology Use: Students in my class use technology to…	0.95	0.98	0.98	0.96	0.97
Express themselves in writing (e.g., word processing).					
Learn and practice skills (e.g., instructional software or educational games).					
Enter, calculate, and graph information (e.g., Excel spreadsheet).					
Create a database of information for a class project (e.g., Filemaker Pro, Access).					
Create and make presentations (e.g., Powerpoint).					

Scale/ Item	Cronbach's Alpha Fall 2004	Spring 2005	Spring 2006	Spring 2007	Spring 2008
Communicate by email with peers, experts, or others on topics they are studying.					
Use online discussions to gather information for an assignment (e.g., through discussion boards or videoconferencing).					
Conduct internet research on an assigned topic.					
Conduct multimedia research (reference CDs, online encyclopedias).					
Enhance or express conceptual understanding through simulation/modeling software.					
Visually represent or investigate concepts (e.g., through concept mapping, graphing, reading charts).					
Produce print products (e.g., desktop publishing).					
Produce multimedia reports/projects (e.g., with video, graphics, and sound editing).					
Analyze information using tools such as graphing calculators or digital microscopes.					
Design web sites or web pages.					
Complete a test or quiz (e.g., online assessments, Texas Math Diagnostic System).					
Other (specify)					
Collaboration: As a teacher, I…	0.90	0.92	0.93	0.92	0.92
Act as a coach or mentor to other teachers or staff at my school. (May include teaching in-service workshop in your school.)					
Receive coaching or mentoring from an external (non-school) source such as a professional curriculum developer.					
Receive coaching or mentoring from an internal source, such as another teacher or technology coordinator.					
Have informal discussions with colleagues regarding strategies for integrating technology.					
Receive feedback from other teachers based on their observations of my teaching.					
Provide feedback to other teachers based on my observations of their teaching.					
Consult with other teachers about certain students' technology skills or use.					
Exchange feedback with other teachers based on student work that used technology.					
Work with a subject-area peer to develop a lesson plan or class activity using technology.					
Work with a colleague in a different subject area to develop a lesson plan.					
Participate in a study group with other teachers on a technology-related topic.					
Technology Integration	0.94	0.95	0.95	0.91	0.91
I alter my instructional use of the classroom computer(s) based upon the newest software applications and research on teaching, learning, and standards-based curriculum.					
My students discover innovative ways to use classroom computers to make a difference in their lives.					
I allocate time for students to practice their computer skills on the classroom computer(s).					
I integrate the most current research on teaching and learning when using the classroom computer(s).					
In my classroom, students use technology-based computer and Internet resources beyond the school (NASA, other government agencies, private sector) to solve authentic problems.					
My students' authentic problem solving is supported by continuous access to a vast array of computer-based tools and technology.					
I plan computer-related activities in my classroom that will improve my students' basic skills (e.g., reading, writing, math computation).					
It is easy for me to design student-centered, integrated curriculum units that use the classroom computer(s) in a seamless fashion.					
I seek out activities that promote increased problem-solving and critical thinking using the classroom computer(s).					
Using cutting edge technology and computers, I have stretched the instructional computing in my classroom.					
Learner-Centered Instruction	0.75	0.80	0.81	0.81	0.83
Students' authentic use of information and inquiry skills guides the type of instructional materials used in my classroom.					
My students are involved in establishing individual goals within the classroom curriculum.					
In addition to traditional assessments, I consistently provide alternative assessment opportunities that encourage students to "showcase" their content understanding in nontraditional ways.					
My instructional approach emphasizes experiential learning, student involvement, and students solving "real-world" issues.					
Resistance to Integration	0.70	0.72	0.77	0.81	0.83
I do <u>not</u> find computers to be a necessary part of classroom instruction.					
Using the classroom computer(s) is <u>not</u> a priority for me this school year.					
I do <u>not</u> find the use of computers to be practical for my students.					

Table C.3. Items and Reliabilities for Student-Level Scales

Scale/ Item	Cronbach's Alpha Fall 2004	Spring 2005	Spring 2006	Spring 2007	Spring 2008
Technology Proficiency: How far along are you in learning to...	0.94	0.94	0.94	0.94	0.94
open, create, modify, print, and save documents					
use a digital camera and/or scanner to get pictures into the computer					
send a document as an attachment to an email					
keep track of Web sites I have visited so that I can return to them later (using bookmarks, etc.)					
enter information on the computer using proper keyboarding skills					
gather information from CD-ROMS					
use online reference databases (online encyclopedias, newspapers, Library of Congress, etc.) to gather information					
use a search engine to find information about a topic (Alamo, etc.) on the Web					
narrow Web searches using key words and Boolean logic (such as "or," "and," or "not")					
use online discussions with experts or mentors to gather information					
evaluate information found on the Web for accuracy					
use a word processor (AppleWorks, Word, etc.) to write and print a story or report					
use a spreadsheet (AppleWorks, Excel, etc.) to enter and calculate numbers					
use a spreadsheet to create graphs					
use a database (AppleWorks, Access, etc.) to enter information					
use a database to search for and sort information and create reports					
use software (Keynote, PowerPoint, etc.) to create a presentation					
use drawing or painting software (Paint, Illustrator, etc.) to create pictures					
use a video camera to make a video					
use software (HyperStudio, Authorware, etc.) to create a multimedia product					
use email to send and receive messages					
use software (FrontPage, Publisher, etc.) to create web pages					
Technology Use in School: In your English language arts, mathematics, social studies, and science classes, how often do your teachers have you...	0.90	0.92	0.91	0.92	0.93
use a word processor (AppleWorks, Word, etc.) to write a story or report.					
use software to learn and practice skills (Riverdeep, Compass Learning, PLATO Learning, etc.).					
use a spreadsheet (Excel, etc.) to enter and calculate numbers or create graphs for an assignment.					
create a database of information (Filemaker Pro, Access, etc.) for a class project.					
create a presentation (PowerPoint, etc.) and present information to classmates or others.					
communicate by email with friends, experts, and others about topics you are studying.					
use online discussions to gather information for an assignment (discussion boards, videoconferencing, etc.).					
conduct Internet research on an assigned topic.					
use tools, such as graphing calculators or digital microscopes, to analyze information.					
produce print products (with desktop publishing software).					
create multimedia reports or projects (with video, graphics, and sound editing).					
use technology to complete a test or quiz.					
Other					
Technical Problems	0.83	0.85	0.84	0.77	0.77
The computer is broken or slow.					
The program I need is not on the computer.					
The Internet connection is too slow or not working.					
A website I need is blocked by a filter.					
Sharing a computer makes it hard to finish assignments.					
My teacher can't fix things when something goes wrong.					
Other (describe)					
Small-Group Work: When students work together in small groups in my classes, we…	0.80	0.83	0.83	0.83	0.83
review and give advice on each other's work.					
tutor or coach each other on difficult work.					
make a presentation for the rest of the class.					
brainstorm solutions to problems.					
discuss previous class assignments.					
produce a report or project.					
School Satisfaction	0.77	0.82	0.80	0.80	0.81
I am satisfied with the work that I do in my classes.					

Scale/ Item	Cronbach's Alpha Fall 2004	Spring 2005	Spring 2006	Spring 2007	Spring 2008
I understand why I am doing the things we do in my classes.					
The things we do in my classes will help me as an adult.					
The work we do in my classes will be useful to me in the job I hope to have as an adult.					
I work hard in my classes because the work is meaningful.					
What I learn in my classes is more important than the grade I receive.					
Self-Directed Learning	0.88	0.89	0.89	0.89	0.88
If I'm confused in class, I ask the teacher or another student for help.					
Sometimes, if I think an assignment is too tough, I purposely don't try hard. Then if I don't do well, I don't feel bad.					
At the end of a project or assignment, I'll think about how hard I worked and whether I would do anything differently next time.					
It's important to me that I understand my schoolwork really well.					
Even when I think my schoolwork is boring, I keep working until I'm finished.					
Before I begin studying, I think about or list the things I'm going to do during my study time.					
Even when I'm supposed to learn about something boring, I keep working until I finish.					
When my teacher writes comments on assignments, I don't read them unless I have to.					
When we start a new unit, I like to know what we're going to be learning and how I'll know if I've learned it well.					
When the teacher calls on me, and I make a mistake in class, I can honestly say that I don't feel bad.					
When I do well on a big project, it's because I've worked hard.					
I work harder than I need to on my schoolwork, because that's just the way I am.					
I'll recopy my notes or make diagrams of what we're learning to try and remember it better.					
I don't like asking for help with my schoolwork.					
If a topic is too hard, it's really hard for me to stay motivated.					
If I know I'm going to do badly on a task, I try to avoid it, even if I know I'd learn a lot from it.					
There are some subjects I'm just bad at.					
A lot of times, I'll wait until the last minute to do my homework or study for a test.					
I know I can make a schedule to get my work done on time and stick to it.					
When I'm doing homework, I rush to finish if I have ,a friend coming over or if a good TV show is about to start.					
I'll look through mistakes I made on earlier assignments so I don't make the same mistakes on new assignments.					
When I'm done writing a report, I read it over carefully and think O about whether I've done a good job.					
Even if I try, I can't make myself concentrate on schoolwork when there are more interesting things to do.					
When I'm reading a chapter, I ask myself questions to make sure I understand the material.					
There are some subjects I just can't understand, even if I try hard.					
When I get a bad grade, I feel dumb.					
I'll pick a tough project where I would learn a lot over an easy project, even if it means I'll have to work harder to get a good grade					
This happens to me a lot: I'll study for a test and think I understand everything; then I take the test and don't do very well.					
I don't really take notes when I'm reading something for school.					
When I get a grade I don't like, I'll spend time trying to figure out what I could have done differently.					
When I do badly on a project, I feel okay as long as I did better than some of the other kids in my class.					
When I answer a question wrong in class, I end up wishing I'd never spoken up.					
When I get a bad grade, it's because I could have studied more or because I should have done something differently, like taking better notes.					
If I'm having trouble concentrating, I find a place to study where I won't be distracted.					
The things we're learning in my class are usually really interesting.					
If I have to choose, I'd rather get good grades in a class than learn a lot.					
When a big project or report is assigned, I make a mental or written schedule to make sure everything gets done on time.					
I'll usually ask someone (like my parents, friends or teacher) to give me feedback on my ideas when I'm working on a big assignment.					
I know from past experience exactly what I have to do (like schedule a certain amount of time, or take notes in a particular way) if I want to do well on my schoolwork.					
If an assignment isn't going to count toward my grade, I don't need to know how well I did on it.					

Scale/ Item	Cronbach's Alpha Fall 2004	Spring 2005	Spring 2006	Spring 2007	Spring 2008
I only feel bad about a low grade if I think I didn't work hard enough, or if I think I made careless mistakes					
When I read, I put the important ideas into my own words.					
When I'm not feeling motivated, I can't, make myself study.					
When I don't understand things in class, I end up thinking it's because I'm not that smart.					
When we have a reading assignment, I'll read through it one time, but I don't really go back through it to check how well I remember it.					
I know I can do well in school if I try hard enough.					
I don't ask for help, even if I don't understand the directions for an assignment.					
I wouldn't do any homework if I didn't have to.					

Appendix D
Measurement of Implementation Fidelity

Defining Technology Immersion

The Texas Education Agency selected three lead vendors as providers of technology immersion packages (Dell Computer, Inc., Apple Computer Inc., and Region 1 Education Service Center [ESC]). Sections to follow provide descriptions of the components of technology immersion packages.

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 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 a student-safe email solution. Region 1 ESC provided Dell products.

Online Instructional and Assessment Resources

Immersion packages included a variety of digital 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), *TeenBiz3000* 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, *AssessmentMaster* (Renaissance Learning) provides a formative assessment in all four core subject areas. Both the Dell and Region 1 ESC packages provide *i-Know* (CTB McGraw Hill) for core-subject assessment. In addition, all campuses have access to the online Texas Mathematics Diagnostic System (TMDS) and Texas Science Diagnostic System (TMDS) that are 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 *Pearson Achievement Solutions*, a commercial provider (formerly *Co-nect*), 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 were expected to include some common required elements, such as support for 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 collaborated with vendors to develop specific professional development plans for their 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. 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 had an online and telephone HelpDesk to answer questions and provide assistance.

In sum, the RFQ process created technology immersion packages with common elements. Still, the complexity and variability of the treatment makes it critically important for researchers to document not only how and how well technology immersion is implemented but also to identify factors that contribute to implementation variations.

Measuring Implementation

In the second through fourth years, we employed a two-part approach to the measurement of implementation fidelity. First, we used indicators to describe each campus' progress on a 4-step scale toward immersion standards. Rating scales for components and related elements identified four levels of immersion: *minimal* (0 to 1.99), *partial* (2.00 to 2.99), *substantial* (3.00 to 3.49), and *full* (3.50 to 4.00). Second, we used quantitative implementation indices that gauged the level of technology immersion using standardized scores (*z* scores). Both the immersion standard scores and implementation indices were derived from values for seven components: (a) Leadership, (b) Teacher Support, (c) Parent and Community Support, (d) Technical Support, (e) Professional Development, (f) Classroom Immersion, and (g) Student Access and Use. The following sections describe the seven components of technology immersion and related measurement procedures. Table D.1 shows the scoring rubrics for immersion indicators, and Table D.2 describes the data sources used to generate scores.

Supports for Implementation

Leadership. Our measure of administrative leadership comes from teacher survey items (12) that yield a Leadership scale score. Items assess the extent to which administrators involved staff in decisions, set clear expectations for technology use, encourage and participate in professional development, have a well-developed technology plan, promote teacher innovation, and provide necessary resources and administrative support. Teachers rated the extent of their agreement on a 5-point scale ranging from 0 (*strongly disagree*) to 4 (*strongly agree*). To achieve substantial to full immersion, teachers had to *agree* or *strongly agree* that administrators provided technology leadership. A Leadership Index was generated by transforming the scale score to a *z* score.

Teacher Support. Although implementation may be affected by the characteristics of individual teachers, it also may reflect the collective disposition of teachers toward the adoption of new and innovative practices. Our measure of teacher commitment to technology immersion comes from teacher survey items (4) measuring a Teacher Support scale (i.e., Innovative Culture). Items gauged the extent to which teachers in the school share an understanding about technology use for student learning, are continually learning and seeking new ideas, are not afraid to learn about and use new technologies, and are generally supportive of technology integration efforts. Teachers rated the extent of their agreement on a 5-point scale ranging from 0 (*strongly disagree*) to 4 (*strongly agree*), with substantial to full immersion tied to the strength of teacher *agreement.* A Teacher Support Index was generated by transforming the scale score to a *z* score.

Parent and Community Support. Support from parents and community members is also a key part of implementation because they must understand the goals of technology immersion, assume responsibility along with their children, and assist in enacting effective policies. Our measure of Parent and Community Support is a scale score composed of teacher survey items (2). These items indicate the extent to which parents support the school's emphasis on technology and the community actively supports instructional efforts with technology. Teachers rated the extent of their agreement on a 5-point scale ranging from 0 (*strongly disagree*) to 4 (*strongly agree*). Substantial to full immersion reflected the strength of teacher agreement. A Parent/Community Support Index was generated by transforming the scale score to a *z* score.

Technical Support. On a fully immersed campus, sufficient technical support and a healthy infrastructure are expected to alleviate technical problems that might interfere with the use of technology in the classroom, school, and beyond. Our measure for technical support comes from teacher survey items (5) contributing to a Technical Support scale score. Teachers indicated the extent of their agreement on a 5-point scale ranging from 0 (*strongly disagree*) to 4 (*strongly agree*) that computers are kept in good working order, requests for assistance are addressed in a timely way, Internet connections work adequately, and classroom materials are readily available. A Technical Support Index was generated by transforming the scale score to a *z* score.

Professional Development. In constructing measures of professional development, we drew 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 provided a framework for examining dimensions of schools' and vendors' professional development models. Data for measures come from core-subject teachers' responses to survey items.

First, we measured the total number of Contact Hours that core-subject teachers spent in technology-related professional development during the past school year. In addition, professional development models for technology immersion were required to include a classroom support component, so we measured Classroom Support as the extent to which core teachers indicated that they received modeling, coaching or mentoring from an internal source (such as another teacher or technology coordinator), or an external source (such a professional curriculum developer). Teachers rated the frequency of support on a 4-point scale linked to standards: 0 (*never)*, 1.33 (*rarely—a few times a year)*, 2.67 (*sometimes—once or twice a month*), and 4 (*often—once or twice a week* or *almost daily)*.

To examine the Content Focus of teachers' activities, we asked each teacher who participated in technology-related professional development to indicate the degree of emphasis the activity placed on curriculum, instructional methods, and lesson development in their core-subject area. Teachers' responses were coded on a 5-point scale with 0 = *no emphasis*, 2 = *minor emphasis*, and 4 =*major emphasis*. As a measure of professional development Coherence, each core teacher who attended technology-related events indicated the extent to which the activity was consistent with the their goals for professional development, was based explicitly on what the teacher had learned in earlier professional development experiences, was followed up with activities that built on what the teacher learned in the professional development activity, was aligned with state or district standards and curriculum frameworks and with state and district assessments. To measure this indicator, teachers used a 5-point scale ranging from 0 (*not at all*) to 4 (*to a great extent*). A Professional Development Index was generated by averaging *z* scores for each of the four professional development elements.

Extent of Implementation

Classroom Immersion. The technology immersion packages included a variety of instructional and assessment resources designed to extend, supplement, or enhance core-subject teaching and learning. Wireless laptops, for example, were loaded with productivity software (i.e., either *Appleworks* or *Microsoft Office*) for students to use as a learning tool. Teachers and students also received a variety of digital resources and formative assessments to support content-area instruction and learning activities. Indicators for Classroom Immersion, accordingly, assessed the extent to which core-subject teachers at immersion campuses utilized resources and embraced practices consistent with the technology immersion model. Classroom Immersion is measured by five elements: Technology Integration, Learner-Centered Instruction, Student Classroom Activities, Communication, and Professional Productivity. Measures of Technology Integration (10 items) and Learner-Centered Instruction (4 items) are scale scores adapted from the Levels of Technology Implementation (LoTi) Questionnaire. Core teachers indicated the extent to which statements related to Technology Integration (e.g., I alter my instructional practices to support higher order thinking through technology) and Learner-Centered Instruction (e.g., I have students use information and inquiry skills) are true on a 5-point scale, including 0 (*not true of me now)*, 1 to 3 (*somewhat true of me now*), and 4 (*very true of me now*).

Because teachers influence students' classroom opportunities to use technology for learning academic content, we also used items from teacher surveys as a way to assess the extent to which teachers had students use various technology applications in core-subject classrooms (Student Classroom Activities). For example, survey items gauged how often students' used a word processor to write a story or used software to learn and practice skills. Teachers' responses were converted to a 5-point scale tied to immersion standards. Responses indicated how often students' in a typical class used technology in particular ways: 0 (*never),* 1.33 (*rarely—a few times a year)*, 2.67 (*sometimes—once or twice a month*), 4.00 (*often—once or twice a week—* or *almost daily).*

Teachers at immersion schools also are expected to use technology as a communication tool. Communication that advances student learning involves sending email to students, parents, or colleagues, or posting information and assignments on a class or school website. Technology also provides a way to improve teachers' Professional Productivity, including the use of technology for purposes such as keeping records, analyzing data, developing lessons, or delivering information. Scale scores for Communication (4 items) and Professional Productivity (11 items) are comprised of teacher responses on a 5-point scale indicating the frequency of activities: 0 (*never*) to 4.00 (*almost daily*). The Classroom Immersion Index was generated by averaging z scores for each of the five elements described above.

Student Access and Use. This indicator gauged the extent of student access to laptop computers as well as the frequency of students' laptop use for learning in core-content classrooms and at home. Three elements—Laptop Access Days, Core-Content Learning, and Home Learning—contribute to the component score. First, in an immersion school, students are expected to have access to wireless laptops for the entire school year. Our measure of Laptop Access was calculated as the number of days out of the 180-day school year that students actually had laptops available for use. Information for the indicator comes from an analysis of student survey items in which students indicated whether the school provided a laptop for student use, and if provided, how many days the laptop had been taken away (e.g., for misuse, misbehavior, failure to complete assignments, bad grades, or repairs). Student access scores, which could range from 0 days (no laptop) to 180 days (laptop available the full school year), were converted to the 0-4.00 continuous scale to measure progress toward the immersion standard. A Laptop Access Index was generated by transforming the continuous score to a z score.

The potential for laptops to affect achievement depends largely on students' opportunities to use technology for learning core academic content. Consequently, we used items from student surveys (4) to assess the frequency with which students used technology resources in their English/language arts, mathematics, science, and social studies classrooms (Core-Content Learning). Students' responses were converted to a 4-point frequency scale tied to standards: 0 (*never or rarely—a few times a year)*, 1.33 (*sometimes—once or twice a month*), 2.67 (*often—once or twice a week),* and 4 (*almost daily)*. A Core-Content Learning Index was generated by transforming the scale score to a z score.

Additionally, on a fully immersed campus, students should have access to their wireless laptops for learning both within and outside of school. Information for the measure of Home Learning comes from student survey items in which students indicated whether the school provided a laptop for student use, how often the student could take a laptop home, and if a laptop could be taken home, how often it was used for homework in core subjects or for learning games. A student's use of the laptop for home learning was rated on a 6-point scale: 0 (*no access to laptop outside of school*), 1 (*restricted or full access to laptop outside of school)*, plus up to 5 additional points if a student used their *laptop for homework in ELA, math, science,* or *social studies*, or for *learning games*. Students' scores were converted to the 0-4.00 scale as a measure of progress toward immersion standards, and a *z* score was generated. We generated the Student Access and Use Index by averaging z scores for each of the three elements described above.

Table D.1. Scoring Rubrics for Measuring the Implementation Fidelity of Technology Immersion—Year 4

Component/Element	Minimal Immersion 0-1.99	Partial Immersion 2.00-2.99	Substantial Immersion 3.00-3.49	Full Immersion 3.50-4.00	Implementation Index
Leadership					
Campus Scores 2.31 to 3.49 M=2.96 SD=0.33	Teachers *disagree or strongly disagree* that administrators establish clear vision and expectations, encourage integration, provide supports, and involve staff in decisions.	Teachers are *unsure* that administrators establish clear vision and expectations, encourage integration, provide supports, and involve staff in decisions.	Teachers *agree* that administrators establish clear vision and expectations, encourage integration, provide supports, and involve staff in decisions.	Teachers *agree or strongly agree* that administrators establish clear vision and expectations, encourage integration, provide supports, and involve staff in decisions.	Campus *z* Scores -1.93 to 1.59
Teacher Support (Innovative Culture)					
Campus Scores 2.76 to 3.70 M=3.14 SD=0.27	Teachers *disagree or strongly disagree* that they share an understanding of technology, continually learn, are unafraid, and support integration.	Teachers are *unsure* that they share an understanding of technology, continually learn, are unafraid, and support integration.	Teachers *agree* that they share an understanding of technology, continually learn, are unafraid, and support integration.	Teachers *agree or strongly agree* that they share an understanding of technology, continually learn, are unafraid, and support integration.	Campus *z* Scores -1.41 to 2.09
Parent and Community Support					
Campus Scores 2.13 to 3.42 M=2.81 SD=0.41	Teachers *disagree or strongly disagree* that parents and the surrounding community support the school's efforts with technology.	Teachers are *unsure* that parents and the surrounding community support the school's efforts with technology.	Teachers *agree* that parents and the surrounding community support the school's efforts with technology.	Teachers *agree or strongly agree* that parents and the surrounding community support the school's efforts with technology.	Campus *z* Scores -1.68 to 1.48
Technical Support					
Campus Scores 2.31 to 3.37 M=2.82 SD=0.31	Teachers *disagree or strongly disagree* that computers are in good condition, Internet connections are adequate, responses to requests are timely, and materials are available.	Teachers are *unsure* that computers are in good condition, Internet connections are adequate, responses to requests are timely, and materials are available.	Teachers *agree* that computers are in good condition, Internet connections are adequate, responses to requests are timely, and materials are available.	Teachers *agree or strongly* that computers are in good condition, Internet connections are adequate, responses to requests are timely, and materials are available.	Campus *z* Scores -1.66 to 1.78

Table D.1. Scoring Rubrics for Measuring the Implementation Fidelity of Technology Immersion—Year 4 (*Continued*)

Component/Element	Minimal Immersion 0-1.99	Partial Immersion 2.00-2.99	Substantial Immersion 3.00-3.49	Full Immersion 3.50-4.00	Implementation Index
Professional Development					Campus *z* Scores
Contact Hours Campus Hours 1.13 (14 hrs) to 4.0 (70 hrs) M=2.52 (33 hrs) SD=1.06	Core-subject teachers, on average, participated in 25 or less hours of PD during the past school year.	Core-subject teachers, on average, participated in 26 to 37 hours of PD during the past school year.	Core-subject teachers, on average, participated in 38 to 49 hours of PD during the past school year.	Core-subject teachers, on average, participated in 50 or more hours of PD during the past school year.	-1.80 to 1.79
Classroom Support Campus Scores 1.37 to 2.93 M=2.14 SD=0.36	Core teachers indicate that they *rarely* or *never* receive classroom coaching or mentoring from an internal or external source.	Core teachers indicate that they *rarely* (a few times a year) receive classroom coaching or mentoring from an internal or external source.	Core teachers indicate that they *sometimes* (once or twice a month) receive classroom coaching or mentoring from an internal or external source.	Core teachers indicate that they *often* (once or twice a week) *or almost daily* receive classroom coaching or mentoring from an internal or external source.	
Content Focus Campus Scores 2.00 to 3.73 M=2.89 SD=0.42	Core teachers indicate there is *no or almost no PD emphasis* on curriculum, instructional methods, and lesson development in core areas.	Core teachers indicate there is *a minor PD emphasis* on curriculum, instructional methods, and lesson development in core areas.	Core teachers indicate there is a *minor* to *major PD emphasis* on curriculum, instructional methods, and lesson development in core areas.	Core teachers indicate there is a *major PD emphasis* on curriculum, instructional methods, and lesson development in core areas.	
Coherence Campus Scores 1.83 to 3.07 M=2.49 SD=0.33	Core teachers indicate that PD is *not at all* consistent with personal and school goals, prior learning, and state standards and assessment.	Core teachers indicate that PD is consistent with personal and school goals, builds on prior learning, and supports state standards and assessment to a *minimal extent*.	Core teachers indicate that PD is consistent with personal and school goals, builds on prior learning, and supports state standards and assessment to a *moderate extent*.	Core teachers indicate that PD is consistent with personal and school goals, builds on prior learning, and supports state standards and assessment to a *great extent*.	
Student Access and Use					Campus *z* Scores
Laptop Access Days Campus Scores 1.80 (81 days) to 3.54 (160 days) M=2.50 (115 days) SD=0.51	Students' laptop access days vary to an *extremely large extent* at a campus, with laptops available from about 80 to 168 days per student.	Students' laptop access days vary to a *large extent* at a campus, with laptops available from about 95 to 175 days per student.	Students' laptop access days vary do a *moderate* extent at a campus, with laptops available from about 140 to 175 days per student.	Students' laptop access days vary to a *small extent* at a campus, with laptops available from about 160 to 180 days per student.	-1.71 to 1.38
Core-Content Learning Campus Scores 1.42 to 2.98 M=2.12 SD=0.48	Students *rarely* (a few times a year) *or never* use technology resources in core-subject classes	Students *sometimes* (once or twice a month) or *often* (once or twice a week) use technology resources in core-subject classes	Students *often* (once or twice a week) or *almost daily* use technology resources in core subjects.	Students use technology resources in core subjects *almost daily.*	
Home Learning Campus Scores 0.40 to 2.58 M=1.84 SD=0.49	Students, on average, use their laptops outside of school for homework or learning either *not at all* or to a *trivial extent*.	Students, on average use their laptops outside of school for homework and learning to a *small extent*.	Students, on average, use their laptops outside of school for homework and learning to a *moderate extent.*	Students, on average, use their laptops outside of school for homework and learning to a *large extent.*	

Table D.1. Scoring Rubrics for Measuring the Implementation Fidelity of Technology Immersion –Year 4 (*Continued)*

Component/Element	Minimal Immersion 0-1.99	Partial Immersion 2.00-2.99	Substantial Immersion 3.00-3.49	Full Immersion 3.50-4.00	Implementation Index
Classroom Immersion					Campus *z* Scores -2.40 to 1.92
Technology Integration Campus Scores 1.72 to 3.65 M=2.64 SD=0.42	Core teachers indicate it is *not true now* that I alter instructional practices, allocate time, integrate research on teaching and learning, improve basic skills, and support higher order thinking through technology.	Core teachers indicate it is *somewhat true now* that I alter instructional practices, allocate time, integrate research on teaching and learning, improve basic skills, and support higher order thinking through technology.	Core teachers indicate it is *somewhat* or *very true now* that I alter instructional practices, allocate time, integrate research on teaching and learning, improve basic skills, and support higher order thinking through technology.	Core teachers indicate it is *very true now* that I alter instructional practices, allocate time, integrate research on teaching and learning, improve basic skills, and support higher order thinking through technology.	
Learner-Centered Instruction Campus Scores 1.58 to 3.55 M=2.62 SD=0.45	Core teachers indicate it is *not true now* that my students establish learning goals, use information and inquiry skills, complete alternative assessments, and have active and relevant experiences.	Core teachers indicate it is *somewhat true now* that my students establish learning goals, use information and inquiry skills, complete alternative assessments, and have active and relevant experiences.	Core teachers indicate it is *somewhat* or *very true now* that my students establish learning goals, use information and inquiry skills, complete alternative assessments, and have active and relevant experiences.	Core teachers indicate it is *very true now* that my students establish learning goals, use information and inquiry skills, complete alternative assessments, and have active and relevant experiences.	
Student Activities Campus Scores 1.79 to 2.97 M=2.39 SD=0.32	Core teachers *rarely or never* have students use technology resources to support core-content learning.	Core teachers *sometimes* have students use technology resources to support core-content learning.	Core teachers *sometimes* to *often* have students use technology resources to support core-content learning.	Core teachers *often* to *almost daily* have students use technology resources to support core-content learning.	
Communication Campus Scores 1.29 to 3.33 M=2.50 SD=0.54	Core teachers *rarely* or *never* use technology to communicate with students, parents, and colleagues or to post information on a class website.	Core teachers *sometimes* use technology to communicate with students, parents, and colleagues or to post information on a class website.	Core teachers *often* use technology to communicate with students, parents, and colleagues or to post information on a class website.	Core teachers *often* to *almost daily* use technology to communicate with students, parents, and colleagues or to post information on a class website.	
Professional Productivity Campus Scores 2.45 to 3.33 M=2.86 SD=0.24	Core teachers *rarely* or *never* use technology to enhance their professional productivity (e.g., keep records, analyze data, develop lessons, deliver information).	Core teachers *sometimes* use technology to enhance their professional productivity (e.g., keep records, analyze data, develop lessons, deliver information).	Core teachers *often* use technology to enhance their professional productivity (e.g., keep records, analyze data, develop lessons, deliver information).	Core teachers *often* to *almost daily* use technology to enhance their professional productivity (e.g., keep records, analyze data, develop lessons, deliver information).	
Implementation Index					Campus *z* Scores -1.55 to 1.89

Table D.2. Data Sources for Technology Immersion Implementation Indicators

Indicator	Source	Item Description	Index Score	Standards-Based Score
Leadership (all teachers)				
	Teacher survey	Q11: Please indicate the extent of your agreement with each of the following statements. c) The principal consults with staff before making decisions about instructional technology that affect us. d) In this school there are clear expectations that technology will be used to enhance student learning. j) The principal in my school actively encourages teachers to pursue professional development geared towards curricular integration of technology. o) Our school has a well-developed technology plan that guides all technology integration efforts. p) The principal is an effective leader for instructional technology in this school. q) Overall, considering the uses of technology in my school today, I am confident that this use is leading to increased student achievement. r) The principal encourages teachers to be innovative and try new methods. t) The principal is willing to support—through funding or manpower—teachers' efforts at technology integration. v) Administrators in this school help teachers to use technology to access, analyze, and interpret student performance data w) Teachers receive adequate administrative support to integrate technology into classroom practice. x) Teachers and administrators rely on research-proven teaching and learning principles in making decisions about technology use. y) When our school has professional development focused on technology, the principal often participates.	5-point scale z score	0 = Strongly Disagree 1 = Disagree 2 = Unsure 3 = Agree 4 = Strongly Agree
Teacher Support (Innovative Culture) (all teachers)				
	Teacher survey	Q11: Please indicate the extent of your agreement with each of the following statements. b) Teachers in this school share an understanding about how technology will be used to enhance learning. i) Teachers in this school are continually learning and seeking new ideas. k) Teachers are not afraid to learn about new technologies and use them with their class(es). aa) Teachers in this school are generally supportive of technology integration efforts.	5-point scale z score	0 = Strongly Disagree 1 = Disagree 2 = Unsure 3 = Agree 4 = Strongly Agree
Parent & Community Support (all teachers)				
	Teacher survey	Q11: Please indicate the extent of your agreement with each of the following statements. f) Parents support our school's emphasis on technology. h) The surrounding community actively supports our instructional efforts with technology.	5-point scale z score	0 = Strongly Disagree 1 = Disagree 2 = Unsure 3 = Agree 4 = Strongly Agree
Technical Support (all teachers)				
	Teacher survey	Q11: Please indicate the extent of your agreement with each of the following statements. a) Most of our school computers are kept in good working condition. b) Internet connections in my class are often too slow or not working. c) My requests for technical assistance are addressed in a timely manner. d) Materials (e.g., software, printer supplies) for classroom use of computers are readily available in my school. e) Problems such as computers freezing or an inability to access the Internet make it difficult for me to use technology.	5-point scale z score	0 = Strongly Disagree 1 = Disagree 2 = Unsure 3 = Agree 4 = Strongly Agree

Table D.2. Data Sources for Technology Immersion Implementation Indicators *(Continued)*

Indicator	Source	Item Description	Index Score	Standards-Based Score
Professional Development (core-subject teachers)				
Contact Hours	Teacher survey	Q20: Indicate the number of hours spent in technology-related professional development (PD) over the past school year (i.e., since August 1, 2006).	Continuous variable 0 to *x** *z* score	Continuous variable 0 to *x* * >= 3 *SD* from mean excluded
Classroom Support	Teacher survey	Q12: About how often do you interact with colleagues in each of the following ways. j) receive coaching or mentoring from an external (non-school) source such as a professional curriculum developer k) receive coaching or mentoring from an internal source, such as another teacher or technology coordinator	5-point scale *z* score	0 = Never 1 = Rarely (a few times a year) 2 = Sometimes (once or twice a month) 3 = Often (once or twice a week) 4 = Almost Daily
Content Focus	Teacher survey	If core-subject teacher participated in technology-related PD, Q24: How much emphasis did the "most time" technology-related professional development activity give to each of the following areas? a) Curriculum (e.g., units, texts, standards) b) Instructional methods d) Lesson development in English language arts, mathematics, science, or social studies [mean of teachers' responses pertinent to their subject-area assignments (e.g., math teachers rate math)]	3-point scale *z* score	0 = No Emphasis 2 = Minor Emphasis 4 = Major Emphasis
Coherence	Teacher survey	If core-subject teacher participated in technology-related PD, Q27: To what extent was the "most time" technology-related professional development activity: a) Consistent with your own goals for professional development b) Consistent with your school's or department's plan to change practice c) Based explicitly on what you had learned in earlier professional development experiences d) Followed up with activities that built upon what you learned in this professional development activity e) Designed to support state or district standards/curriculum frameworks f) Designed to support state or district assessment	5-point scale *z* score	0 = Not at All 1 2 3 4 = Great Extent
Classroom Immersion (core-subject teachers)				
Technology Integration	Teacher survey	Q12: Please indicate your present level of classroom technology implementation. c) I alter my instructional use of the classroom computer(s) based upon the newest software applications and research on teaching, learning, and standards-based curriculum. d) My students discover innovative ways to use classroom computers to make a difference in their lives. e) I allocate time for students to practice their computer skills on the classroom computer(s). g) I integrate the most current research on teaching and learning when using the classroom computer(s). h) In my classroom, students use technology-based computer and Internet resources beyond the school (NASA, other government agencies, private sector) to solve authentic problems. i) My students' authentic problem solving is supported by continuous access to a vast array of computer-based tools and technology. k) I plan computer-related activities in my classroom that will improve my students' basic skills (e.g., reading, writing, math computation). l) It is easy for me to design student-centered, integrated curriculum units that use the classroom computer(s) in a seamless fashion. n) I seek out activities that promote increased problem-solving and critical thinking using the classroom computer(s). o) Using cutting edge technology and computers, I have stretched the instructional computing in my classroom.	7-point scale *z* score	0 = Not true of me now 1 = Somewhat true of me now 2 = Somewhat true of me now 3 = Somewhat true of me now 4 = Very true of me now

Table D.2. Data Sources for Technology Immersion Implementation Indicators *(Continued)*

Indicator	Source	Item Description	Index Score	Standards-Based Score
Classroom Immersion *(Continued)*				
Learner-Centered Instruction	Teacher survey	Q12: Please indicate your present level of classroom technology implementation. b) Students authentic use of information and inquiry skills guides the type of instructional materials used in my classroom. j) My students are involved in establishing indivual goals within the classroom curriculum. m) In additional to traditional assessments, I consistently provide alternative assessment opportunities that encourage students to "showcase" their content understanding in nontraditional ways. q) My instructional approach emphasizes experiential learning, student involvement, and students solving "real-world" issues.	7-point scale z score	0 = Not true of me now 1 = Somewhat true of me now 2 = Somewhat true of me now 3 = Somewhat true of me now 4 = Very true of me now
Student Classroom Activities	Teacher survey	Q16: About how often do students in your typical class use technology in the following ways during class time. Students in my class use technology to… a) express themselves in writing (e.g., word processing). b) learn and practice skills (e.g., instructional software or educational games). c) enter, calculate, and graph information (e.g., Excel spreadsheet). d) create a database of information for a class project (e.g., Filemaker Pro, Access). e) create and make presentations (e.g., PowerPoint). f) communicate by email with peers, experts, or others on topics they are studying. h) conduct Internet research on an assigned topic. i) conduct multimedia research (reference CDs, online encyclopedias). j) enhance or express conceptual understanding through simulation/modeling software. k) visually represent or investigate concepts (e.g., through concept mapping, graphing, reading charts). l) produce print products (e.g., desktop publishing). m) produce multimedia reports/projects (e.g., with video, graphics, and sound editing). n) analyze information using tools such as graphing calculators or digital microscopes. p) complete a test or quiz (e.g., online assessments, Texas Math Diagnostic System).	5-point scale z score	0 = Never 1.333 = Rarely (a few times a year) 2.667 = Sometimes (once or twice a month) 4 = Often (once or twice a week) or Almost Daily
Communication	Teacher survey	Q13: About how often do you use technology in each of the following ways? As a teacher I… e) communicate with students. f) communicate with parents. g) communicate with colleagues/other professionals. m) post homework, class requirements, or project information on a website.	5-point scale z score	0 = Never 1 = Rarely (a few times a year) 2 = Sometimes (once or twice a month) 3 = Often (once or twice a week) 4 = Almost Daily
Professional Productivity	Teacher survey	Q13: About how often do you use technology in each of the following ways? As a teacher I… a) keep administrative records (e.g., attendance). b) manage student assessment data (e.g., electronic gradebooks). c) use technology to analyze and interpret student data to guide my instruction. d) create electronic lesson plans. h) create instructional materials (e.g., tests, handouts). i) gather information from the Internet to create a lesson (e.g., text, video, clipart). j) access model lesson plans integrating technology. k) deliver information using presentation software (e.g., PowerPoint). l) deliver information using multimedia presentations (text, audio, video, graphics). p) use the Internet at home for instructional purposes. q) use a computer to do schoolwork at home.	5-point scale z score	0 = Never 1 = Rarely (a few times a year) 2 = Sometimes (once or twice a month) 3 = Often (once or twice a week) 4 = Almost Daily

Table D.2. Data Sources for Technology Immersion Implementation Indicators (*Continued)*

Indicator	Source	Item Description	Index Score	Standards-Based Score
Student Access and Use				
Laptop Access Days	Student survey	Q3.a: Does your school provide a laptop that you can use? [Yes = 180 days, No = 0 days] Q3.b: Have you had a laptop taken away from you for more than a class period? [No = 180 - 0 days; Yes = 180 – Q3.d. no laptop days] Q3.d: How many days was the laptop taken away? [1 to 180]	Continuous variable 0 to 180 z score	Continuous variable 0 to 180 4 = Meet or exceed expectations 0-3.99 = proportional fraction of requirement [campus mean adjusted for variance (-2 SDs)]
Core-Content Learning	Student survey	Q6: About how often do you use technology in each of the following classes? a) Reading/English language arts b) Math c) Science d) Social studies	5-point scale z score	0 = Never or Rarely (a few times a year) 1.333 = Sometimes (once or twice a month) 2.667 = Often (once or twice a week) 4 = Almost Daily
Home Learning	Student survey	Q4.a: How often can you take a laptop home? [0 = Never (no access); 1 = Only when I have a project or assignment or Other (restricted access) or As often as I want (full access)] Q4.b: When you take a laptop home, how do you use it? Homework for language arts (reading/writing) [+1] Homework for social studies [+1] Homework for science [+1] Homework for math [+1] Play games to learn [+1]	Continuous variable 0 to 6 z score	Continuous variable 0 to 6 0 = No access to laptop outside school 1 = Restricted or full access to laptop outside school + Laptop used for homework and/or learning outside of school (up to 5 points) 4 = Meet or exceed expectations 0-3.99 = proportional fraction of requirement
Implementation Index			Composite z score	

Appendix E
Technical Appendix—Hierarchical Linear Modeling (HLM)

Effects of Technology Immersion on Teachers and Teaching (Chapter 4)

Researchers estimated the effects of immersion on teacher mediating variables using three-level hierarchical linear growth models. In our models, we posit that school poverty is related to teachers' initial status and yearly growth rate. Statistical details are provided in Tables E.1, E.2, and E.3. The models' simplicity aids in the interpretation of effects. More complex models, controlling for teacher demographic characteristics (gender, ethnicity, experience), described subsequently in Tables E.4, E.5 and E.6, estimated nearly identical immersion growth coefficients.

Table E.1. Descriptive Statistics for Teacher Variables: HLM Models with School Poverty

Variable Name	*N*	*Mean*	*SD*
Repeated Measures Descriptive Statistics (Level 1)			
Survey Time	10,685	2.00	1.41
Technology Proficiency	5,541	4.96	1.40
Professional Productivity	5,484	3.30	0.73
Technology Integration	5,219	3.79	1.58
Learner-Centered Instruction	5,390	4.19	1.38
Resistance to Integration	5,426	2.36	1.40
Student Classroom Activities	5,448	2.19	0.81
Collaboration	5,487	2.53	0.78
School-Level Descriptive Statistics (Level 3)			
Immersion status (1 = yes, 0 = no)	42	0.50	0.51
School percent economically disadvantaged	42	68.52	16.83

Table E.2. Immersion (Fixed) Effect Analyses of Teacher Mediating Variables: HLM Models with School Poverty

School-Level Scale	School-Level Analysis	Gamma Coefficient	Standard Error	*t*
Technology Proficiency				
	Initial status (fall 2004)	4.692	0.081	58.26***
	Immersion dummy	-0.165	0.112	-1.48
	School poverty	0.001	0.003	0.16
	Growth rate	0.147	0.014	10.53***
	Immersion dummy	0.138	0.023	6.06***
	School poverty	-0.002	0.001	-3.23**
Professional Productivity				
	Initial status (fall 2004)	3.011	0.058	51.53***
	Immersion dummy	-0.062	0.078	-0.80
	School poverty	0.001	0.002	0.57
	Growth rate	0.110	0.009	12.17***
	Immersion dummy	0.069	0.014	4.92***
	School poverty	0.000	0.000	-0.66
Technology Integration				
	Initial status (fall 2004)	2.847	0.073	38.95***
	Immersion dummy[a]	0.445	0.097	4.61***
	School poverty	0.010	0.003	3.50**
	Growth rate[a]	0.002	0.532	0.00
	Immersion dummy[a]	0.105	0.093	1.14
	School poverty[a]	-0.005	0.002	-2.30*
	Initial status[a]	0.103	0.187	0.55

Continued

Table E.2. Immersion (Fixed) Effect Analysis of Teacher Mediating Variables (Continued)

Learner-Centered Instruction				
	Initial status (fall 2004)	3.683	0.065	56.37***
	Immersion dummy	0.036	0.092	0.39
	School poverty	0.006	0.002	2.62*
	Growth rate	0.199	0.017	11.75***
	Immersion dummy	0.110	0.032	3.42**
	School poverty	-0.002	0.001	-2.08*
Resistance to Integration				
	Initial status (fall 2004)	2.463	0.055	44.57***
	Immersion dummy[b]	-0.295	0.070	-4.24***
	School poverty	-0.003	0.002	-1.75†
	Growth rate	0.011	0.013	0.86
	Immersion dummy[b]	0.024	0.023	1.03
	School poverty	0.002	0.000	3.69**
Student Classroom Activities				
	Initial status (fall 2004)	1.858	0.047	39.52***
	Immersion dummy[c]	0.161	0.061	2.65*
	School poverty	0.004	0.002	2.56*
	Growth rate	0.073	0.012	5.90***
	Immersion dummy[c]	0.101	0.018	5.60***
	School poverty	-0.001	0.001	-2.51*
Collaboration				
	Initial status (fall 2004)	2.292	0.048	48.04***
	Immersion dummy[d]	0.143	0.062	2.29*
	School poverty	0.004	0.002	2.30*
	Growth rate	0.055	0.014	3.97***
	Immersion dummy[d]	0.018	0.019	0.95
	School poverty	0.000	0.001	0.15

†*p* < .10; **p* < .05; ***p* < .01; ****p* < .001.

[a]Immersion teachers had significantly higher initial technology integration scores. A latent variable regression was run to control for the effect of this initial difference on the growth rate. The latent variable regression indicated that the immersion effect became not significant after controlling for initial differences. Thus, the coefficients from the latent variable regression model are reported here.

[b]Immersion teachers had significantly lower initial resistance to integration scores. A latent variable regression was run to control for the effect of this initial difference on the growth rate. The immersion effect was not a significant predictor of the growth rate with and without controlling for initial differences. Thus, the coefficients from the original growth model are reported here.

[c]Immersion teachers had significantly higher initial student classroom activities scores. A latent variable regression was run to control for the effect of this initial difference on the growth rate. The immersion effect was a significant predictor of the growth rate with and without controlling for initial differences. Thus, the coefficients from the original growth model are reported here.

[d]Immersion teachers had significantly higher initial teacher collaboration scores. A latent variable regression was run to control for the effect of this initial difference on the growth rate. The immersion effect was not a significant predictor of the growth rate with and without controlling for initial differences. Thus, the coefficients from the original growth model are reported here.

Table E.3. Variance Decomposition from Conditional HLM Growth Models of Teacher Mediating Variables (with School Poverty)

Scale/ Random Effect	Variance Component	*df*	X^2	*p*
Technology Proficiency				
Level-1 temporal variation	0.3272			
Level-2 individual initial status	1.7749	1377	9689.69	0.000
Level-2 individual growth rate	0.0299	1377	2066.54	0.000
Level-2 school initial status	0.0577	39	94.09	0.000
Level-2 school growth rate	0.0018	39	71.96	0.001
Professional Productivity				
Level-1 temporal variation	0.1580			
Level-2 individual initial status	0.3185	1368	4356.51	0.000
Level-2 individual growth rate	0.0094	1368	1898.50	0.000
Level-2 school initial status	0.0447	39	163.93	0.000
Level-2 school growth rate	0.0006	39	69.27	0.002
Technology Integration				
Level-1 temporal variation	0.7740			
Level-2 individual initial status	1.2219	1326	3609.38	0.000
Level-2 individual growth rate	0.0299	1326	1761.13	0.000
Level-2 school initial status	0.0341	39	70.04	0.002
Level-2 school growth rate	0.0077	39	97.43	0.000
Learner-Centered Instruction				
Level-1 temporal variation	0.7208			
Level-2 individual initial status	0.9869	1355	3392.48	0.000
Level-2 individual growth rate	0.0224	1355	1635.95	0.000
Level-2 school initial status	0.0330	39	77.57	0.000
Level-2 school growth rate	0.0043	39	86.90	0.000
Resistance to Integration				
Level-1 temporal variation	0.9160			
Level-2 individual initial status	0.7162	1362	2592.57	0.000
Level-2 individual growth rate	0.0320	1362	1727.09	0.000
Level-2 school initial status	0.0058	39	49.46	0.122
Level-2 school growth rate	0.0002	39	44.90	0.238
Student Classroom Activities				
Level-1 temporal variation	0.2316			
Level-2 individual initial status	0.2861	1364	3195.86	0.000
Level-2 individual growth rate	0.0047	1364	1725.86	0.000
Level-2 school initial status	0.0218	39	110.90	0.000
Level-2 school growth rate	0.0015	39	89.94	0.000
Collaboration				
Level-1 temporal variation	0.2554			
Level-2 individual initial status	0.2713	1372	2932.92	0.000
Level-2 individual growth rate	0.0102	1372	1742.01	0.000
Level-2 school initial status	0.0233	39	111.78	0.000
Level-2 school growth rate	0.0015	39	83.64	0.000

Researchers also used HLM growth models to estimate immersion effects on teacher mediating variables, controlling for teacher characteristics. Statistical details for these models are provided in Tables E.4, E.5 and E.6.

Table E.4. Descriptive Statistics for Teacher Variables: HLM models with Teacher Characteristics

Variable Name	*N*	*Mean*	*SD*
Repeated Measures Descriptive Statistics (Level 1)			
Time	9,430	2.00	1.41
Technology Proficiency	5,403	4.95	1.40
Professional Productivity	5,351	3.29	0.73
Technology Integration	5,088	3.78	1.58
Learner-Centered Instruction	5,256	4.18	1.37
Resistance to Integration	5,289	2.35	1.39
Student Classroom Activities	5,316	2.18	0.80
Collaboration	5,353	2.53	0.78
Teacher-Level Descriptive Statistics (Level 2)			
Male	1,886	0.33	0.47
Hispanic	1,886	0.35	0.48
African American	1,886	0.05	0.22
Experience	1,886	10.66	9.61
School-Level Descriptive Statistics (Level 3)			
Immersion status (1 = yes, 0 = no)	42	0.50	0.51

Table E.5. Immersion (Fixed) Effect Analyses of Teacher-Level Variables: HLM Models with Teacher Characteristics

School-Level Scale	School-Level Analysis	Gamma Coefficient	Standard Error	*t*
Technology Proficiency				
	Initial status (fall 2004)	4.845	0.073	66.34***
	Immersion dummy[a]	-0.186	0.083	-2.23*
	Male	-0.090	0.087	-1.04
	Hispanic	-0.166	0.074	-2.24*
	African American	-0.017	0.135	-0.13
	Experience	-0.055	0.004	-12.87***
	Growth rate	0.123	0.015	8.29***
	Immersion dummy[a]	0.139	0.026	5.32***
	Male	-0.018	0.018	-1.01
	Hispanic	0.014	0.022	0.63
	African American	0.008	0.023	0.36
	Experience	0.004	0.001	5.86***
Professional Productivity				
	Initial status (fall 2004)	3.093	0.058	52.90***
	Immersion dummy	-0.061	0.073	-0.85
	Male	-0.200	0.051	-3.92***
	Hispanic	0.032	0.046	0.70
	African American	0.095	0.076	1.25
	Experience	-0.014	0.003	-5.12***
	Growth rate	0.093	0.011	8.30***
	Immersion dummy	0.067	0.014	4.69***
	Male	0.014	0.014	1.05
	Hispanic	0.011	0.010	1.11
	African American	0.018	0.022	0.81
	Experience	0.001	0.001	1.74[†]

(*Continued*)

Table E.5. Immersion (Fixed) Effect Analysis of Teacher-Level Variables (Continued)

Technology Integration				
	Initial status (fall 2004)	2.855	0.076	37.76***
	Immersion dummy[b]	0.441	0.099	4.44***
	Male	-0.187	0.068	-2.74**
	Hispanic	0.301	0.086	3.50**
	African American	0.513	0.091	5.62***
	Experience	-0.017	0.004	-4.24***
	Growth rate	0.296	0.029	10.14***
	Immersion dummy[b]	0.145	0.042	3.49**
	Male	-0.004	0.022	-0.17
	Hispanic	-0.055	0.024	-2.27*
	African American	-0.008	0.040	-0.21
	Experience	0.003	0.001	2.55*
Learner-Centered Instruction				
	Initial status (fall 2004)	3.757	0.064	58.35***
	Immersion dummy	0.021	0.087	0.24
	Male	-0.240	0.069	-3.47**
	Hispanic	0.166	0.065	2.56*
	African American	0.484	0.103	4.68***
	Experience	-0.025	0.004	-6.61***
	Growth rate	0.175	0.019	9.30***
	Immersion dummy	0.104	0.034	3.03**
	Male	0.003	0.027	0.12
	Hispanic	0.012	0.023	0.53
	African American	0.022	0.037	0.60
	Experience	0.003	0.001	2.58*
Resistance to Integration				
	Initial status (fall 2004)	2.416	0.061	39.51***
	Immersion dummy[c]	-0.319	0.061	-5.28***
	Male	0.410	0.076	5.42***
	Hispanic	-0.325	0.060	-5.40***
	African American	-0.342	0.110	-3.10**
	Experience	0.013	0.004	3.20**
	Growth rate	-0.003	0.019	-0.17
	Immersion dummy[c]	0.024	0.023	1.05
	Male	0.033	0.026	1.25
	Hispanic	0.060	0.019	3.10**
	African American	0.038	0.058	0.65
	Experience	-0.004	0.001	-2.71**
Student Classroom Activities				
	Initial status (fall 2004)	1.817	0.047	38.78***
	Immersion dummy[d]	0.160	0.056	2.85**
	Male	-0.045	0.052	-0.85
	Hispanic	0.185	0.041	4.49***
	African American	0.299	0.077	3.91***
	Experience	-0.004	0.002	-2.11*
	Growth rate	0.068	0.014	4.77***
	Immersion dummy[d]	0.098	0.020	4.94***
	Male	0.017	0.017	1.04
	Hispanic	-0.016	0.013	-1.22
	African American	-0.002	0.025	-0.08
	Experience	0.000	0.000	-0.27

(*Continued*)

Table E.5. Immersion (Fixed) Effect Analysis of Teacher-Level Variables (Continued)

Collaboration				
	Initial status (fall 2004)	2.265	0.043	52.91***
	Immersion dummy[e]	0.145	0.056	2.58*
	Male	-0.022	0.042	-0.54
	Hispanic	0.145	0.047	3.08**
	African American	0.332	0.072	4.64***
	Experience	-0.007	0.002	-3.58**
	Growth rate	0.047	0.015	3.06**
	Immersion dummy[e]	0.014	0.018	0.79
	Male	0.010	0.011	0.90
	Hispanic	0.004	0.015	0.29
	African American	-0.029	0.027	-1.08
	Experience	0.000	0.001	0.59

[†]$p < .10$; *$p < .05$; **$p < .01$; ***$p < .001$.

[a]Immersed teachers had significantly lower initial technology proficiency scores. A latent variable regression was run to control for the effect of this initial difference on the growth rate. The immersion effect was a significant predictor of the growth rate with and without controlling for initial differences. Thus, the coefficients from the original growth model are reported here.

[b]Immersed teachers had significantly higher technology integration scores. A latent variable regression was run to control for the effect of this initial difference on the growth rate. The immersion effect was a significant predictor of the growth rate with and without controlling for initial differences. Thus, the coefficients from the original growth model are reported here.

[c]Immersed teachers had significantly lower initial resistance to integration scores. A latent variable regression was run to control for the effect of this initial difference on the growth rate. The immersion effect was not a significant predictor of the growth rate with and without controlling for initial differences. Thus, the coefficients from the original growth model are reported here.

[d]Immersion teachers had significantly higher initial student classroom activities scores. A latent variable regression was run to control for the effect of this initial difference on the growth rate. The immersion effect was a significant predictor of the growth rate with and without controlling for initial differences. Thus, the coefficients from the original growth model are reported here.

[e]Immersion teachers had significantly higher initial teacher collaboration scores. A latent variable regression was run to control for the effect of this initial difference on the growth rate. The immersion effect was not a significant predictor of the growth rate with and without controlling for initial differences. Thus, the coefficients from the original growth model are reported here.

Table E.6. Variance Decomposition from Conditional HLM Growth Models of Teacher Mediating Variables (with Teacher Characteristics)

Scale/ Random Effect	Variance Component	*df*	X^2	*p*
Technology Proficiency				
Level-1 temporal variation	0.3282			
Level-2 individual initial status	1.5267	1357	8450.52	0.000
Level-2 individual growth rate	0.0280	1357	2014.06	0.000
Level-2 school initial status	0.0186	40	64.26	0.009
Level-2 school growth rate	0.0032	40	101.56	0.000
Professional Productivity				
Level-1 temporal variation	0.1577			
Level-2 individual initial status	0.2915	1350	4076.97	0.000
Level-2 individual growth rate	0.0089	1350	1864.75	0.000
Level-2 school initial status	0.0376	40	149.66	0.000
Level-2 school growth rate	0.0007	40	70.95	0.002
Technology Integration				
Level-1 temporal variation	0.7729			
Level-2 individual initial status	1.1650	1307	3461.82	0.000
Level-2 individual growth rate	0.0295	1307	1739.92	0.000
Level-2 school initial status	0.0373	40	70.72	0.002
Level-2 school growth rate	0.0107	40	119.00	0.000
Learner-Centered Instruction				
Level-1 temporal variation	0.7187			
Level-2 individual initial status	0.9173	1336	3190.64	0.000
Level-2 individual growth rate	0.0210	1336	1602.35	0.000
Level-2 school initial status	0.0263	40	74.50	0.001
Level-2 school growth rate	0.0059	40	104.31	0.000
Resistance to Integration				
Level-1 temporal variation	0.9170			
Level-2 individual initial status	0.6278	1342	2453.70	0.000
Level-2 individual growth rate	0.0305	1342	1702.84	0.000
Level-2 school initial status	0.0024	40	42.51	0.363
Level-2 school growth rate	0.0003	40	41.46	0.407
Student Classroom Activities				
Level-1 temporal variation	0.2300			
Level-2 individual initial status	0.2771	1345	3118.26	0.000
Level-2 individual growth rate	0.0047	1345	1706.70	0.000
Level-2 school initial status	0.0157	40	95.91	0.000
Level-2 school growth rate	0.0022	40	107.71	0.000
Collaboration				
Level-1 temporal variation	0.2546			
Level-2 individual initial status	0.2644	1353	2867.76	0.000
Level-2 individual growth rate	0.0096	1353	1718.12	0.000
Level-2 school initial status	0.0154	40	93.97	0.000
Level-2 school growth rate	0.0015	40	83.79	0.000

Effects of Technology Immersion on Students and Learning (Chapter 5)

For the results reported in Chapter 5, researchers analyzed the effects of immersion on student mediating variables for Cohorts 2 and 3 using three-level HLM models.

Effects on Mediating Variables

In spring 2007, student surveys were not administered at two treatment campuses and one control campus. We used AMOS 7.0 to perform model-based imputations to predict these missing scores. Specifically, for Cohort 2, we imputed scores for the three school technology scales and for the three self-perception scales. For Cohort 3, we also imputed scores for the three school technology scales and for only two self-perception scales because self-directed learning was not studied in Cohort 3. Our student-level model predicted the spring 2007 student scale score from the spring 2006 scale score for Cohort 2 and from the fall 2006 scale score for Cohort 3, gender (1 if female, 0 if male), African-American status (1 if African American, 0 if not), Hispanic status (1 if Hispanic, 0 if not), economic status (1 if on free- or reduced-lunch, 0 if not), and immersion status (1 if the student attended an immersion campus, 0 if he or she attended a control campus). The result was five complete datasets for each scale for Cohorts 2 and 3.

These multiply-imputed datasets were then analyzed using HLM 6.04. (Note that HLM results from 10 imputed datasets were compared to the results from 5 imputed datasets, and there were essentially no differences in the coefficients. The reduced number of imputed datasets made the HLM analyses mechanically easier to run.) Specifically, researchers used three-level HLM growth models, with controls for school poverty (percentage of economically disadvantaged students) and student poverty (qualification for free- or reduced-price lunch). The models' simplicity aids in the interpretation of effects. Statistical details are provided in Tables E.7, E.8, and E.9 for analyses of mediating variables for Cohort 2.

Table E.7. Descriptive Statistics for Student Variables, Cohort 2

Variable Name	*N*	*Mean*[a]	*SD*
Repeated Measure Descriptive Statistics (Level 1)			
Time	18,108	1.50	1.12
Time (SLI)	17,220	1.50	1.12
Technology Proficiency score	14,720	3.28	0.91
Classroom Activities score	14,160	2.37	0.84
Technical Problems score	14,311	2.41	0.93 to 0.94
Small-Group Work score	14,151	2.80	0.88
School Satisfaction score	14,305	3.69	0.76
Self-Directed Learning score	13,276	4.49	0.74
Student-Level Descriptive Statistics (Level 2)			
Eco. disadvantaged (1 = yes, 0 = no)	4,527	0.67	0.47
Eco. disadvantaged (SLI)	4,305	0.66	0.47
School-Level Descriptive Statistics (Level 3)			
Immersion status (1 = yes, 0 = no)	42	0.50	0.51
School poverty (percentage)	42	68.52	16.83

[a]Range of imputed means is listed when means differed across imputations.

Table E.8. Immersion (Fixed) Effect Analyses of Student Mediating Variables, Cohort 2

School-Level Scale	School-Level Analysis	Gamma Coefficient	Standard Error	*t*
Technology Proficiency				
	Initial status (fall 2005)	2.982	0.055	54.45***
	Immersion dummy	-0.002	0.076	-0.02
	School poverty	0.002	0.002	0.93
	Disadvantaged	-0.264	0.045	-5.90***
	Growth rate	0.256	0.023	11.34***
	Immersion dummy	0.094	0.031	3.06**
	School poverty	-0.001	0.001	-0.59
	Disadvantaged	0.004	0.018	0.25
Self-Directed Learning				
	Initial status (fall 2005)	4.721	0.044	107.37***
	Immersion dummy	-0.043	0.055	-0.78
	School poverty	0.003	0.002	1.58
	Disadvantaged	-0.096	0.026	-3.64**
	Growth rate	-0.142	0.013	-11.05***
	Immersion dummy	0.013	0.018	0.74
	School poverty	0.000	0.001	0.30
	Disadvantaged	0.002	0.011	0.21
School Satisfaction				
	Initial status (fall 2005)	3.829	0.029	130.76***
	Immersion dummy	0.038	0.037	1.03
	School poverty	0.000	0.001	-0.36
	Disadvantaged	-0.140	0.022	-6.31***
	Growth rate	-0.058	0.012	-4.90***
	Immersion dummy	-0.018	0.018	-0.99
	School poverty	0.001	0.000	2.56*
	Disadvantaged	0.029	0.011	2.71**
Classroom Activities (with technology)				
	Initial status (fall 2005)	2.058	0.052	39.61***
	Immersion dummy[a]	0.247	0.082	3.00**
	School poverty	0.006	0.002	2.64*
	Disadvantaged	-0.005	0.039	-0.12
	Growth rate	0.099	0.029	3.41**
	Immersion dummy[a]	0.092	0.041	2.26*
	School poverty	-0.003	0.001	-2.35*
	Disadvantaged	0.029	0.015	1.88[†]
Small-Group Work				
	Initial status (fall 2005)	2.762	0.050	55.26***
	Immersion dummy	-0.024	0.070	-0.34
	School poverty	0.002	0.002	1.28
	Disadvantaged	0.002	0.045	0.04
	Growth rate	0.007	0.017	0.43
	Immersion dummy	0.091	0.029	3.12**
	School poverty	-0.001	0.001	-1.15
	Disadvantaged	0.003	0.017	0.20

(*Continued*)

Table E.8. Immersion (Fixed) Effect Analysis of Student Variables, Cohort 2 (Continued)

Technical Problems				
	Initial status (fall 2005)	2.209	0.044	50.50***
	Immersion dummy[b]	-0.284	0.066	-4.32***
	School poverty	0.005	0.002	2.31*
	Disadvantaged	-0.058	0.028	-2.07*
	Growth rate	0.145	0.028	5.15***
	Immersion dummy[b]	0.198	0.036	5.57***
	School poverty	-0.002	0.001	-2.14*
	Disadvantaged	0.019	0.015	1.33

[†]$p < .10$; *$p < .05$; **$p < .01$; ***$p < .001$.
[a]Immersion students had significantly higher initial classroom activities scores. A latent variable regression was run to control for the effect of this initial difference on the growth rate. The immersion effect was a significant predictor of the growth rate with and without controlling for initial differences. Thus, the coefficients from original growth model are reported here.
[b]Immersion students had significantly lower initial technical problems scores. A latent variable regression was run to control for the effect of this initial difference on the growth rate. The immersion effect was a significant predictor of the growth rate with and without controlling for initial differences. Thus, the coefficients from original growth model are reported here.

Table E.9. Variance Decomposition from Conditional HLM Models of Student Mediating Variables, Cohort 2

Test/ Random Effect	Variance Component	*df*	X^2	*p*
Technology Proficiency				
Level-1 temporal variation	0.3147			
Level-2 individual initial status	0.4328	4154	11431.32	0.000
Level-2 individual growth rate	0.0294	4154	5858.72	0.000
Level-3 school initial status	0.0511	39	305.41	0.000
Level-3 school growth rate	0.0084	39	310.70	0.000
Self-Directed Learning				
Level-1 temporal variation	0.2250			
Level-2 individual initial status	0.3096	3684	10269.22	0.000
Level-2 individual growth rate	0.0232	3684	5187.67	0.000
Level-3 school initial status	0.0233	39	214.15	0.000
Level-3 school growth rate	0.0019	39	125.16	0.000
School Satisfaction				
Level-1 temporal variation	0.3591			
Level-2 individual initial status	0.2084	4101	7025.10	0.000
Level-2 individual growth rate	0.0175	4101	4956.99	0.000
Level-3 school initial status	0.0074	39	98.11	0.000
Level-3 school growth rate	0.0017	39	97.32	0.000
Classroom Activities				
Level-1 temporal variation	0.4495			
Level-2 individual initial status	0.1890	4069	6093.71	0.000
Level-2 individual growth rate	0.0141	4069	4671.39	0.000
Level-3 school initial status	0.0615	39	378.97	0.000
Level-3 school growth rate	0.0159	39	493.31	0.000

(*Continued*)

Table E.9. Variance Decomposition from Conditional HLM Models of Student Mediating Variables, Cohort 2 (Continued)

Small-Group Work				
Level-1 temporal variation	0.5443			
Level-2 individual initial status	0.2461	4075	6194.30	0.000
Level-2 individual growth rate	0.0286	4075	4883.41	0.000
Level-3 school initial status	0.0398	39	230.69	0.000
Level-3 school growth rate	0.0063	39	184.97	0.000
Technical Problems				
Level-1 temporal variation	0.5597			
Level-2 individual initial status	0.1590	4100	5565.16	0.000
Level-2 individual growth rate	0.0236	4100	4966.56	0.000
Level-3 school initial status	0.0336	39	211.20	0.000
Level-3 school growth rate	0.0108	39	241.79	0.000

Statistical details are provided in Tables E.10, E.11, and E.12 for analyses of mediating variables for Cohort 3.

Table E.10. Descriptive Statistics for Student Variables, Cohort 3

Variable Name	*N*	*Mean*[a]	*SD*
Repeated Measure Descriptive Statistics (Level 1)			
Time	13,158	1.00	0.82
Technology Proficiency score	11,354	4.30	0.90
Classroom Activities score	11,178	2.34	0.86
Technical Problems score	11,170	2.28	0.92 to 0.93
Small-Group Work score	11,109	2.80	0.88 to 0.89
School Satisfaction score	11,115	3.71	0.75
Student-Level Descriptive Statistics (Level 2)			
Eco. disadvantaged (1 = yes, 0 = no)	4,386	0.69	0.46
Eco. disadvantaged (SLI)			
School-Level Descriptive Statistics (Level 3)			
Immersion status (1 = yes, 0 = no)	42	0.50	0.51
School poverty (percentage)	42	68.52	16.83

[a]Range of imputed means is listed when means differed across imputations.

Table E.11. Immersion (Fixed) Effect Analyses of Student Mediating Variables, Cohort 3

School-Level Scale	School-Level Analysis	Gamma Coefficient	Standard Error	*t*
Technology Proficiency				
	Initial status (fall 2006)	2.951	0.057	52.10***
	Immersion dummy	-0.019	0.084	-0.22
	School poverty	0.001	0.002	0.45
	Disadvantaged	-0.145	0.043	-3.38**
	Growth rate	0.266	0.019	13.75***
	Immersion dummy	0.168	0.036	4.68***
	School poverty	-0.001	0.001	-1.37
	Disadvantaged	-0.010	0.018	-0.57
School Satisfaction				
	Initial status (fall 2006)	3.797	0.027	138.60***
	Immersion dummy	0.050	0.038	1.33
	School poverty	-0.001	0.001	-1.05
	Disadvantaged	-0.084	0.022	-3.81***
	Growth rate	-0.092	0.022	-4.29***
	Immersion dummy	0.022	0.031	0.69
	School poverty	0.001	0.001	0.95
	Disadvantaged	0.035	0.020	1.74
Classroom Activities (with technology)				
	Initial status (fall 2006)	1.967	0.088	22.45***
	Immersion dummy[a]	0.436	0.119	3.67**
	School poverty	0.004	0.004	1.13
	Disadvantaged	0.002	0.063	0.03
	Growth rate[a]	1.067	0.126	8.47***
	Immersion dummy[a]	0.217	0.052	4.20***
	School poverty[a]	-0.003	0.001	0.044*
	Disadvantaged	0.059	0.037	1.58
	Initial status[a]	-0.464	0.062	-7.49***
Small-Group Work				
	Initial status (fall 2006)	2.785	0.067	41.57***
	Immersion dummy	-0.015	0.086	-0.18
	School poverty	0.002	0.003	0.79
	Disadvantaged	-0.031	0.053	-0.58
	Growth rate	-0.039	0.034	-1.17
	Immersion dummy	0.144	0.047	3.09**
	School poverty	-0.001	0.001	-0.94
	Disadvantaged	0.036	0.029	1.25

(*Continued*)

Table E.11. Immersion (Fixed) Effect Analysis of Student Variables, Cohort 3 (Continued)

Technical Problems				
	Initial status (fall 2006)	2.136	0.057	37.66***
	Immersion dummy[b]	-0.139	0.072	-1.92†
	School poverty	-0.003	0.002	-1.67
	Disadvantaged	-0.047	0.043	-1.11
	Growth rate	0.152	0.037	4.12***
	Immersion dummy[b]	0.235	0.048	4.91***
	School poverty	0.001	0.002	0.39
	Disadvantaged	-0.001	0.019	-0.05

†$p < .10$; *$p < .05$; **$p < .01$; ***$p < .001$.

[a]Immersion students had significantly higher initial classroom activities scores. A latent variable regression was run to control for the effect of this initial difference on the growth rate. The latent variable regression indicated that the immersion effect became significant after controlling for initial differences. Thus, the coefficients from the latent variable regression model are reported here.

[b]Immersion students had significantly lower initial technical problems scores. A latent variable regression was run to control for the effect of this initial difference on the growth rate. The immersion effect was a significant predictor of the growth rate with and without controlling for initial differences. Thus, the coefficients from original growth model are reported here.

Table E.12. Variance Decomposition from Conditional HLM Models of Student Mediating Variables, Cohort 3

Test/ Random Effect	Variance Component	*df*	X^2	*p*
Technology Proficiency				
Level-1 temporal variation	0.2964			
Level-2 individual initial status	0.4858	3996	11277.03	0.000
Level-2 individual growth rate	0.0495	3996	5243.04	0.000
Level-3 school initial status	0.0548	39	313.12	0.000
Level-3 school growth rate	0.0084	39	176.43	0.000
School Satisfaction				
Level-1 temporal variation	0.3465			
Level-2 individual initial status	0.1805	3922	6093.07	0.000
Level-2 individual growth rate	0.0249	3922	4426.58	0.000
Level-3 school initial status	0.0076	39	102.19	0.000
Level-3 school growth rate	0.0057	39	135.20	0.000
Classroom Activities				
Level-1 temporal variation	0.43751			
Level-2 individual initial status	0.2095	3947	5969.44	0.000
Level-2 individual growth rate	0.0241	3947	4360.33	0.000
Level-3 school initial status	0.1348	39	885.50	0.000
Level-3 school growth rate	0.0473	39	609.68	0.000

(*Continued*)

Table E.12. Variance Decomposition from Conditional HLM Models of Student Mediating Variables, Cohort 3 (Continued)

Small-Group Work				
Level-1 temporal variation	0.5243			
Level-2 individual initial status	0.2422	3927	5857.82	0.000
Level-2 individual growth rate	0.0302	3927	4341.39	0.000
Level-3 school initial status	0.0663	39	445.03	0.000
Level-3 school growth rate	0.0160	39	222.70	0.000
Technical Problems				
Level-1 temporal variation	0.5548			
Level-2 individual initial status	0.1473	3942	5131.19	0.000
Level-2 individual growth rate	0.0277	3942	4425.55	0.000
Level-3 school initial status	0.0415	39	292.47	0.000
Level-3 school growth rate	0.0171	39	234.29	0.000

Effects on School Attendance

Comparable to analyses for student-level variables, we used three-level HLM growth models to estimate the effects of immersion on student attendance. Statistical details are provided in Tables E.13, E.14, and E.15.

Table E.13. Descriptive Statistics for Student Attendance

Variable Name	*N*	*Mean*	*SD*
Cohort 2 Repeated Measures Descriptive Statistics (Level 1)			
Year	16,816	1.50	1.12
Attendance	16,703	96.69	3.84
Cohort 3 Repeated Measures Descriptive Statistics (Level 1)			
Year	13,851	1.00	0.82
Attendance	13,742	96.67	3.80
Cohort 2 Student-Level Descriptive Statistics (Level 2)			
Eco. disadvantaged (1 = yes, 0 = no)	4,204	0.73	0.45
Cohort 3 Student-Level Descriptive Statistics (Level 2)			
Eco. disadvantaged (1 = yes, 0 = no)	4,617	0.74	0.44
Cohorts 2 and 3 School-Level Descriptive Statistics			
Immersion status (1 = yes, 0 = no)	42	0.50	0.51
Percentage school poverty (2007-08)	42	68.52	16.83

Table E.14. Immersion (Fixed) Effect Analyses of Student Attendance

Group	School-Level Analysis	Gamma Coefficient	Standard Error	*t*
Cohort 2				
	Initial attendance (2005)	97.587	0.144	677.01***
	Immersion dummy	-0.232	0.173	-1.34
	School poverty	0.014	0.005	2.59*
	Eco. disadvantaged	-0.356	0.124	-2.86**
	Growth rate	-0.189	0.060	-3.15***
	Immersion dummy	-0.059	0.069	-0.86
	School poverty	0.001	0.002	0.40
	Eco. disadvantaged	-0.288	0.035	-8.35***
Cohort 3				
	Initial attendance (2006)	97.600	0.137	711.39***
	Immersion dummy[a]	-0.476	0.237	-2.01*
	School poverty	0.022	0.005	4.12***
	Eco. disadvantaged	-0.567	0.132	-4.31***
	Growth rate	-0.295	0.094	-3.15**
	Immersion dummy[a]	-0.100	0.118	-0.85
	School poverty	-0.001	0.004	-0.32
	Eco. disadvantaged	-0.115	0.048	-2.40*

$^{\dagger}p < .10$; $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$.

[a]Immersed students had significantly lower initial 2006 attendance rates. A latent variable regression was run to control for the effect of this initial difference on the growth rate. The immersion effect was not a significant predictor of the growth rate with and without controlling for initial differences. Thus, the coefficients from the original growth model are reported here.

Table E.15. Variance Decomposition from Conditional HLM Models of Student Attendance, Cohorts 2 and 3

Cohort/ Random Effect	Variance Component	*df*	X^2	*pt*
Cohort 2				
Level-1 temporal variation	4.5174			
Level-2 individual initial status	5.4200	4161	11188.54	0.000
Level-2 individual growth rate	0.9423	4161	8450.03	0.000
Level-3 school initial status	0.1469	39	102.02	0.000
Level-3 school growth rate	0.0234	39	88.90	0.000
Cohort 3				
Level-1 temporal variation	4.9719			
Level-2 individual initial status	5.6117	4574	10711.18	0.000
Level-2 individual growth rate	0.7939	4574	6060.58	0.000
Level-3 school initial status	0.4016	39	191.65	0.000
Level-3 school growth rate	0.0870	39	148.07	0.000

Effects of Technology Immersion on Student Achievement (Chapter 6)

Researchers used three-level HLM growth models to estimate the effects of immersion on student academic achievement. Statistical details are provided for Cohort 2 students (eighth graders) in Tables E.16 through E.19, for Cohort 3 (seventh graders) in Tables E.20 through E.23, and for Cohort 1 students (ninth graders, post immersion) in Tables E.24 through E.26.

Cohort 2 (Eighth Graders)

Table E.16. Descriptive Statistics for TAKS Reading and Mathematics, Cohort 2

Variable Name	*N*	*Mean*	*SD*
Repeated Measures Descriptive Statistics: Reading (Level 1)			
Time	13,072	1.50	1.12
TAKS Reading T score	12,771	48.90	9.57
Repeated Measures Descriptive Statistics: Mathematics (Level 1)			
Time	13,072	1.50	1.12
TAKS Mathematics T score	12,745	48.86	9.28
Student-Level Descriptive Statistics: Reading (Level 2)			
Eco. disadvantaged (1 = yes, 0 = no)	3,268	0.70	0.46
Student-Level Descriptive Statistics: Mathematics (Level 2)			
Eco. disadvantaged (1 = yes, 0 = no)	3,268	0.70	0.46
School-Level Descriptive Statistics: (Level 3)			
Immersion status (1 = yes, 0 = no)	42	0.50	0.51
School poverty (percentage)	42	68.52	16.83

Table E.17. Descriptive Statistics for TAKS Science and Social Studies, Cohort 2

Variable Name	*N*	*Mean*	*SD*
Student-Level Descriptive Statistics: Science (Level 1)			
Female	3,268	0.52	0.50
African American	3,268	0.07	0.25
Hispanic	3,268	0.69	0.46
Eco. disadvantaged (1 = yes, 0 = no)	3,268	0.70	0.46
TAKS Science T score (2005)	3,025	49.09	9.58
TAKS Science T score (2008)	3,211	48.56	9.22
Student-Level Descriptive Statistics: Social Studies (Level 1)			
Female	3,268	0.52	0.50
African American	3,268	0.07	0.25
Hispanic	3,268	0.69	0.46
Eco. disadvantaged (1 = yes, 0 = no)	3,268	0.70	0.46
TAKS Reading T score (2005)	3,015	49.02	9.50
TAKS Social Studies T score (2008)	3,209	48.49	9.36
School-Level Descriptive Statistics (Level 2)			
Immersion status (1 = yes, 0 = no)	42	0.50	0.51
School poverty (percentage)	42	68.52	16.83

Table E.18. Immersion (Fixed) Effect Analyses of TAKS Achievement, Cohort 2

TAKS Achievement Test	School-Level Analysis	Gamma Coefficient	Standard Error	*t*-value
Reading				
	Initial status (spring 2005)	52.427	0.510	102.75***
	Immersion dummy	-0.315	0.581	-0.54
	School poverty	-0.091	0.014	-6.69***
	Eco. disadvantaged	-5.664	0.596	-9.50***
	Growth rate	0.131	0.121	1.08
	Immersion dummy	0.234	0.151	1.55
	School poverty	0.010	0.005	1.95†
	Eco. disadvantaged	0.308	0.105	2.95**
Mathematics				
	Initial status (spring 2005)	52.152	0.572	91.21***
	Immersion dummy	-0.891	0.653	-1.37
	School poverty	-0.052	0.019	-2.70*
	Eco. disadvantaged	-4.623	0.594	-7.78***
	Growth rate	-0.230	0.191	-1.20
	Immersion dummy	0.653	0.253	2.58*
	School poverty	0.005	0.008	0.70
	Eco. disadvantaged	0.179	0.111	1.61
Science				
	Base	50.839	0.627	81.14***
	Immersion dummy	0.475	0.728	0.65
	School poverty	0.033	0.023	1.41
	Female	-0.036	0.289	-0.13
	African American	-1.902	0.782	-2.43*
	Hispanic	-1.484	0.493	-3.01**
	Eco. disadvantaged	-1.611	0.367	-4.39***
	Spring 2005 T score	0.641	0.023	28.00***
Social Studies				
	Base	51.850	0.961	53.95***
	Immersion dummy	0.006	0.994	0.01
	School poverty	0.030	0.029	1.03
	Female	-2.049	0.304	-6.75***
	African American	-1.938	0.737	-2.63**
	Hispanic	-1.058	0.518	-2.04*
	Eco. disadvantaged	-1.616	0.492	-3.29**
	Spr. 2005 reading T score	0.537	0.019	27.88***

†$p < .10$; *$p < .05$; **$p < .01$; ***$p < .001$.

Table E.19. Variance Decomposition from Conditional HLM Models of Student Achievement, Cohort 2

Test/ Random Effect	Variance Component	*df*	X^2	*p*
Reading				
Level-1 temporal variation	26.4556			
Level-2 individual initial status	52.6110	3219	11794.71	0.000
Level-2 individual growth rate	0.8584	3219	3749.75	0.000
Level-3 school initial status	1.7646	39	135.21	0.000
Level-3 school growth rate	0.1302	39	118.03	0.000
Mathematics				
Level-1 temporal variation	19.6036			
Level-2 individual initial status	56.7500	3205	15825.10	0.000
Level-2 individual growth rate	0.7844	3205	3827.95	0.000
Level-3 school initial status	2.9283	39	179.24	0.000
Level-3 school growth rate	0.5526	39	429.52	0.000
Science				
Level-1 student effect	39.8845			
School mean	5.8506	39	322.70	0.000
School pre-measure-outcome slope	0.0114	41	106.45	0.000
Social Studies				
Level-1 student effect	50.4949			
School mean	10.2243	39	368.23	0.000
School pre-measure-outcome slope	0.0078	41	76.71	0.001

Cohort 3 (Seventh Graders)

Table E.20. Descriptive Statistics for TAKS Reading and Mathematics, Cohort 3

Variable Name	*N*	*Mean*	*SD*
Repeated Measures Descriptive Statistics: Reading (Level 1)			
Time	10,965	1.00	0.82
TAKS Reading T score	10,488	48.80	9.77
Repeated Measures Descriptive Statistics: Mathematics (Level 1)			
Time	10,965	1.00	0.82
TAKS Mathematics T score	10,549	49.15	9.37
Student-Level Descriptive Statistics: Reading (Level 2)			
Eco. disadvantaged (1 = yes, 0 = no)	3,655	0.72	0.45
Student-Level Descriptive Statistics: Mathematics (Level 2)			
Eco. disadvantaged (1 = yes, 0 = no)	3,655	0.72	0.45
School-Level Descriptive Statistics: (Level 3)			
Immersion status (1 = yes, 0 = no)	42	0.50	0.51
School poverty (percentage)	42	68.52	16.83

Table E.21. Descriptive Statistics for TAKS Writing, Cohort 3

Variable Name	*N*	*Mean*	*SD*
Student-Level Descriptive Statistics : Writing (Level 1)			
Female	3,672	0.51	0.50
African American	3,672	0.06	0.23
Hispanic	3,672	0.70	0.46
Eco. disadvantaged (1 = yes, 0 = no)	3,655	0.72	0.45
TAKS Writing T score (2005)	3,086	50.42	9.41
TAKS Writing T score (2008)	3,672	49.15	10.59
School-Level Descriptive Statistics: (Level 2)			
Immersion status (1 = yes, 0 = no)	42	0.50	0.51
School poverty (percentage)	42	68.52	16.83

Table E.22. Immersion (Fixed) Effect Analyses of TAKS Achievement, Cohort 3

TAKS Achievement Test	School-Level Analysis	Gamma Coefficient	Standard Error	*t*-value
Reading				
	Initial status (spring 2006)	52.775	0.533	99.01***
	Immersion dummy	-0.751	0.571	-1.31
	School poverty	-0.083	0.017	-4.78***
	Eco. disadvantaged	-5.123	0.750	-6.83***
	Growth rate	-0.104	0.198	-0.53
	Immersion dummy	0.105	0.183	0.58
	School poverty	0.015	0.006	2.38*
	Eco. disadvantaged	0.109	0.171	0.64
Mathematics				
	Initial status (spring 2006)	52.557	0.661	79.46***
	Immersion dummy[a]	-1.465	0.669	-2.19*
	School poverty	-0.040	0.019	-2.10*
	Eco. disadvantaged	-3.893	0.660	-5.90***
	Growth rate	-0.417	0.216	-1.93[†]
	Immersion dummy[a]	0.787	0.292	2.69*
	School poverty	0.025	0.008	3.05**
	Eco. disadvantaged	-0.325	0.198	-1.64
Writing				
	Base	51.390	0.500	102.75***
	Immersion dummy	-0.723	0.579	-1.25
	School poverty	0.003	0.017	0.17
	Female	-0.218	0.278	-0.78
	African American	-1.099	0.423	-2.60*
	Hispanic	-0.407	0.542	-0.75
	Eco. disadvantaged	-2.001	0.339	-5.91***
	Spring 2005 T score	0.644	0.025	25.61***

[†]$p < .10$; *$p < .05$; **$p < .01$; ***$p < .001$.
[a]Immersion students had significantly higher initial TAKS mathematics scores. A latent variable regression was run to control for the effect of this initial difference on the growth rate. The immersion effect was a significant predictor of the growth rate with and without controlling for initial differences. Thus, the coefficients from original growth model are reported here.

Table E.23. Variance Decomposition from Conditional HLM Models of Student Achievement, Cohort 3

Test/ Random Effect	Variance Component	*df*	X^2	*p*
Reading				
Level-1 temporal variation	27.9341			
Level-2 individual initial status	56.5296	3581	24077.87	0.000
Level-2 individual growth rate	Effect not random[a]			
Level-3 school initial status	1.7255	39	117.95	0.000
Level-3 school growth rate	0.1450	39	78.03	0.000
Mathematics				
Level-1 temporal variation	23.0755			
Level-2 individual initial status	56.2365	3582	28796.33	0.000
Level-2 individual growth rate	Effect not random[a]			
Level-3 school initial status	3.4352	39	185.96	0.000
Level-3 school growth rate	0.6815	39	217.18	0.000
Writing				
Level-1 student effect	54.5226			
School mean	2.7112	39	123.22	0.000
School pre-measure-outcome slope	0.0099	41	75.27	0.001

[a]Using chi-square to compare the deviance of the models with and without the individual growth rate being random showed that the addition of the individual growth rate being random resulted in a negligible contribution to the explanation of the outcome variance.

Cohort 1 (Ninth Graders, Post-Immersion)

Table E.24. Descriptive Statistics for TAKS Reading and Mathematics, Cohort 1

Variable Name	*N*	*Mean*	*SD*
Repeated Measures Descriptive Statistics: Reading (Level 1)			
Time	16,555	2.00	1.41
TAKS Reading T score	15,777	48.91	9.68
Repeated Measures Descriptive Statistics: Mathematics (Level 1)			
Time	16,555	2.00	1.41
TAKS Mathematics T score	15,806	49.28	9.45
Student-Level Descriptive Statistics: Reading (Level 2)			
Eco. disadvantaged (1 = yes, 0 = no)	3,311	0.71	0.45
Student-Level Descriptive Statistics: Mathematics (Level 2)			
Eco. disadvantaged (1 = yes, 0 = no)	3,311	0.71	0.45
School-Level Descriptive Statistics: (Level 3)			
Immersion status (1 = yes, 0 = no)	42	0.50	0.51
School poverty (percentage)	42	68.52	16.83

Table E.25. Immersion (Fixed) Effect Analyses of TAKS Achievement, Cohort 1

TAKS Achievement Test	School-Level Analysis	Gamma Coefficient	Standard Error	*t*-value
Reading				
	Initial status (spring 2004)	53.283	0.654	81.430***
	Immersion dummy	-1.205	0.730	-1.650
	School poverty	-0.072	0.016	-4.451***
	Eco. disadvantaged	-6.271	0.586	-10.707***
	Growth rate	-0.014	0.088	-0.158
	Immersion dummy	0.203	0.105	1.932†
	School poverty	0.008	0.003	2.902**
	Eco. disadvantaged	0.367	0.084	4.371***
Mathematics				
	Initial status (spring 2004)	52.372	0.729	71.820***
	Immersion dummy	-1.122	0.883	-1.270
	School poverty	-0.046	0.020	-2.307*
	Eco. disadvantaged	-4.523	0.501	-9.029***
	Growth rate	0.221	0.128	1.726†
	Immersion dummy	0.313	0.196	1.602
	School poverty	0.008	0.006	1.398
	Eco. disadvantaged	-0.126	0.118	-1.073

†$p < .10$; *$p < .05$; **$p < .01$; ***$p < .001$.

Table E.26. Variance Decomposition from Conditional HLM Models of Student Achievement, Cohort 1

Test/ Random Effect	Variance Component	*df*	X^2	*p*
Reading				
Level-1 temporal variation	26.3757			
Level-2 individual initial status	59.4712	3193	14295.82	0.000
Level-2 individual growth rate	0.3824	3193	3656.23	0.000
Level-3 school initial status	3.8714	39	184.90	0.000
Level-3 school growth rate	0.0589	39	96.98	0.000
Mathematics				
Level-1 temporal variation	19.6943			
Level-2 individual initial status	60.7862	3189	18778.21	0.000
Level-2 individual growth rate	0.6443	3189	4181.73	0.000
Level-3 school initial status	6.5953	39	240.93	0.000
Level-3 school growth rate	0.3645	39	331.65	0.000