EVALUATION OF THE TEXAS TECHNOLOGY IMMERSION PILOT

Findings from the Second Year

May 2007

Prepared for
Texas Education Agency

Prepared by
Texas Center for Educational Research

Credits

Texas Center for Educational Research

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Research Funded by

U.S. Department of Education

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Executive Summary

The Technology Immersion Pilot (TIP) sets forth a vision for technology immersion in Texas public schools. The Texas Education Agency (TEA) originally directed more than $14.5 million in federal Title II, Part D monies toward funding a wireless learning environment for high-need middle schools through a competitive grant process. A concurrent research project funded by a federal Evaluating State Educational Technology Programs grant is evaluating whether student achievement improves over time as a result of exposure to technology immersion. The Texas Center for Educational Research (TCER)—a non-profit research organization in Austin—is the TEA's primary partner in this four-year endeavor.

The overarching purpose of the study is 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). Technology immersion encompasses multiple components, including a laptop computer for every middle school student and teacher, wireless access throughout the campus, online curricular and assessment resources, professional development and ongoing pedagogical support for curricular integration of technology resources, and technical support to maintain an immersed campus.

Technology Immersion

As a way to ensure consistent interpretation of technology immersion and comparability across sites, the TEA issued a Request for Qualifications (RFQ) that allowed commercial vendors to apply to become providers of technology immersion packages. Successful vendor applicants to the RFQ had to include the following six components in their plan:

- A wireless mobile computing device for each educator and student on an immersed campus to ensure on-demand access to technology;
- Productivity, communication, and presentation software for use as 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 a competitive application and 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]). Prices for packages varied according to the numbers of students and teachers, the type of laptop computer, and the vendor provider. Package costs ranged from about $1,100 to $1,600 per student. Of the 22 immersion sites, 6 middle schools selected the Apple package, 15 selected the Dell package, and 1 school selected the Region 1 ESC package (Dell computer).

Methodology

Evaluation Design

The evaluation employs a quasi-experimental research design, and in the first year, included 22 experimental and 22 control schools. In the project's second year, however, the research design was modified when two middle schools in one district (one experimental and one control) were lost due to damage caused by Hurricane Rita on the Texas Gulf coast. Thus, second-year results (for the 2005-06 school year) are for the remaining 21 treatment and 21 control schools. A re-analysis of baseline data for the new sample revealed that school and student characteristics generally were unchanged and differences between comparison groups remained statistically insignificant.

In the second year, researchers examined the nature of project implementation at the immersion sites. Additionally, we gauged the effects of technology immersion on teacher and student mediating variables as well as the effects of immersion on students' reading, mathematics, and writing achievement. Research questions are as follows.

- How is technology immersion implemented, and what factors are associated with higher implementation levels?
- What is the effect of technology immersion on teachers and teaching?
- What is the effect of technology immersion on students and learning? and
- Does technology immersion affect student achievement?

The *Theoretical Framework for Technology Immersion* guides the evaluation. The experimental research design allows an estimate of the effects of the intervention, which is the difference between the treatment and control groups. The framework postulates a linear sequence of causal relationships. First, experimental schools are to be "immersed" in technology through the introduction of technology immersion components. An improved school environment for technology should then lead to teachers who have greater technology proficiency, use technology more often for their own professional productivity, collaborate more with their peers, have students use technology more in their classrooms, and use laptops and digital resources to increase the intellectual challenge of lessons. In turn, these improved school and classroom conditions should lead students to greater technology proficiency, more opportunities for peer collaboration, greater personal self-direction, more rigorous and authentic learning experiences, 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, prior student achievement and student, family, and school characteristics exert their own influence on learning.

Participating Sites

Interested districts and associated middle schools responded to a Request for Application (RFA) offered by the TEA in spring 2004 to become technology immersion 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). Technology immersion schools, selected through the competitive grant process, were matched by researchers with control schools on key characteristics, including size, regional location, demographics, and student achievement.

The TIP grants targeted high-need schools, thus nearly 70% of students in the study come from economically disadvantaged backgrounds, with many schools in rural or isolated locations. Students are ethnically diverse, roughly 58% Hispanic and 7% African American. Middle schools are typically small (402 students, on average), but enrollments vary widely (from 83 to 1,447 students). Although schools are highly concentrated in rural and very small Texas districts, about a third of districts and schools are in large cities or suburban locations across the state.

The second-year study focused on two student cohorts. Cohort 1 included 5,538 seventh graders (2,627 immersion, 2,911 control) who completed their second project year; Cohort 2 included 5,507 sixth graders (2,685 immersion, 2,822 control) who finished their first year. Altogether, 1,257 teachers participated in the project (604 at immersion and 653 at control campuses).

Data Collection and Analysis

Data collection involved a mix of qualitative and quantitative data sources. Researchers conducted site visits at each of the middle schools in fall 2004 and spring of 2005 and 2006. For this report, we concentrate on site-visit data gathered through observations in a sample of sixth- and seventh-grade classrooms (English/language arts, mathematics, social studies, and science). Additional measures include annual online teacher surveys and student paper-and-pencil surveys. 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), and data on student disciplinary actions from schools.

We used either two- or three-level hierarchical linear models (HLM) to analyze immersion effects on teachers' and students' perceptions of technology and proficiencies and immersion effects on students' TAKS achievement. Three-level HLM growth modeling estimated the effects of immersion on rates of growth for dependent variables across three time points (2004, 2005, and 2006). When only two data points were available, we used two-level HLM models to estimate the effects of immersion on 2006 scores. For two-level HLM models, we calculated effect sizes (ES) in standard deviation units (usually Cohen's *d)*. Effect sizes greater than 0.5 are typically interpreted as large, 0.5 to 0.3 as moderate, 0.3-0.1 as small, and less than 0.1 as trivial.

The generalization of findings to a broader population is a 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, and schools are located either in small or very small districts or large districts. Additionally, the study relies on self-reported data from students and teachers for many outcome variables. Nonetheless, the triangulation of evidence from multiple sources (surveys, classroom observations, state demographic and test databases, student cohorts) verifies the robustness of findings.

Major Findings

Summary of First- and Second-Year Findings

Our first-year report—*Evaluation of the Texas Technology Immersion Pilot: First-Year Results* (Shapley et al., 2006a)—revealed positive effects of technology immersion on schools, teachers, and students. Findings for the second year relative to these same variables are generally consistent with first-year results. Steadfast outcomes across two evaluation years and two student cohorts show that immersing a middle school in technology produces schools with stronger principal leadership for technology, greater teacher collaboration and collective support for technology innovation, and stronger parent and community support for technology. Additionally, teachers in immersion schools are more technically proficient and use technology more often for their own professional productivity, their students use technology more often in core-subject classrooms, and teachers adopt more integration-oriented and learner-centered ideologies. Students in immersion schools are more technically proficient, use technology more often for learning, interact more often with their peers in small-group activities, and have fewer disciplinary problems than control-group students.

Also consistent with first-year results, we found no significant effect of technology immersion in the second year on student self-directed learning, and we found a significantly negative immersion effect on student attendance. Moreover, the availability of technology across two years provided no significant increase in the intellectual challenge of immersion teachers' core-subject lessons.

First-year findings on academic achievement revealed no statistically significant immersion effects on TAKS reading or mathematics scores for Cohort 1, sixth graders. Similarly, second-year results for Cohort 1 students (as seventh graders) showed no significant effects of immersion on TAKS reading, mathematics, or writing achievement. Likewise, achievement results for Cohort 2 students (sixth graders involved in the project for one year) revealed no significant effect of immersion on TAKS reading achievement. However, for TAKS mathematics, students in immersion schools who began the year with higher math pretest scores had significantly higher mathematics achievement than their control-group counterparts. The math achievement gap favoring immersion students over control widened as students' pretest scores increased. Although TAKS score differences between immersion and control schools usually did not differ by statistically significant margins, second-year achievement trends, in contrast to first-year results, generally favored technology immersion schools. Additional details for second-year outcomes are provided below.

Major Second-Year Findings

Effects of Immersion on Teachers and Teaching

Immersion teachers grew in technology proficiency and in their use of technology for professional productivity at significantly faster rates than control teachers. Technology immersion accelerated teachers' growth in meeting the state's Technology Application Standards. In a self-assessment of their technology proficiency across three time points, immersion teachers considered themselves to be increasingly more technology literate than control teachers in areas involving technology operations and pedagogical skills. Similarly, teachers in immersion schools used technology significantly more often for administrative and classroom management purposes.

Teachers in immersion schools expressed stronger ideological associations across time with technology integration and learner-centered practices. While immersion and control teachers initially expressed similar views on instructional practices involving technology, immersion teachers changed their instructional beliefs at a significantly more positive rate. Immersion teachers indicated that they increasingly employed technology integration actions, 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, emphasizing experiential learning, and providing real-world experiences.

Teachers at schools with higher concentrations of student poverty grew in technology proficiency and adopted new ideologies at slower rates. Teachers who taught at schools with higher student poverty levels grew in technology proficiency and embraced technology integration and learner-centered practices at slower rates than their peers in more advantaged schools. Weaker supports for implementation at more impoverished immersion schools as well as the characteristics of teachers employed in those schools (proportionately more male teachers who were less likely than females to embrace innovative methods) may at least partially explain immersion teachers' progress.

Given greater abundance of technology, teachers in immersion schools collaborated more often with their peers on technology-related issues than control teachers, and students used technology more often in immersion classrooms. Teachers at immersion schools compared to control had a significantly steeper growth rate for collaborative interactions with colleagues that supported improvements in instructional practices (e.g., developing lesson plans, exchanging information about students), as well as for the frequency of their students' classroom activities involving technology. Despite their positive growth trend, statistics indicated that by spring 2006 teachers in immersion classrooms had students use various technology resources infrequently (i.e., about once or twice a month). While the overall level of classroom technology use was low, practices varied across teachers and core-subject areas.

Availability of technology resources had little, if any, effect on the intellectual challenge of immersion teachers' lessons. Technology immersion's theorized impact on student achievement hinges on technology's facilitation of more rigorous and authentic learning experiences. Observations of core-subject teachers in fall 2004 and spring of 2005 and 2006 revealed no statistically significant differences between the intellectual demand of immersion and control teachers' lessons. Across classrooms, lessons generally failed to intellectually challenge students. Observed activities most often focused on student acquisition of facts, definitions, and algorithms, and less often centered on writing lesson-related communication, constructing knowledge (e.g., synthesizing, explaining), or engaging in disciplined inquiry (e.g., investigation, experimental inquiry).

Effects of Immersion on Students and Learning

Technology immersion significantly increased students' technology proficiency and narrowed the gap between economically advantaged and disadvantaged students. Immersion students made greater progress toward mastery of the Texas Technology Applications standards. Estimated yearly growth in proficiency for economically advantaged and disadvantaged immersion students in Cohort 1 were nearly twice the rates for their control-group counterparts. Consequently, by the end of seventh grade, economically disadvantaged students in immersion schools surpassed advantaged control students in proficiency. Similarly, for Cohort 2, sixth graders, immersion had a significantly positive effect on students' technology proficiency (ES = 0.30).

Students in immersion schools used technology significantly more often in core-subject classrooms and interacted more frequently with their peers in small groups. Similar to their teachers' reports, Cohort 1 students at immersion schools had a significantly steeper growth trend for the frequency of classroom activities with technology than control students. Results for Cohort 2 students, similarly, revealed significant and practically important differences in classroom activities favoring immersion schools (ES = 0.83). Along with greater uses of classroom technology, students in immersion schools also had more frequent opportunities to learn with other students in small groups and to take a more active learning role.

Although immersion students used technology more often, classroom observations showed that they used technology in rather conventional ways. Observed students most frequently used a word processor for writing, learned and practiced skills (typically multi-choice exercises or digitized worksheets), created or made presentations (using PowerPoint or Keynote), or conducted Internet searches for information on an assigned topic. In general, changes in classroom activities and organizational structures in immersion classrooms did not necessarily alter the rigor or relevance of students' experiences with core-subject content.

Technology immersion had no significant effect on student self-directed learning. We theorized that opportunities for independent and self-guided learning afforded through one-to-one technology would positively affect students' personal self-direction. Findings in the second year replicated first-year results showing there was no significant immersion effect on self-directed learning. As both immersion and control students in Cohort 1 progressed from sixth to seventh grade, their responses to statements measuring self-direction revealed a significantly negative growth trend. Results for Cohort 2 students, similarly, revealed no significant immersion effect (ES = 0.03).

Outcomes for student engagement varied. Students in immersion schools had significantly fewer disciplinary actions, similar levels of school satisfaction, and significantly lower school attendance rates than control-group students. One-to-one computing is often credited with increasing student engagement as measured by indicators such as stronger commitment to academic work, increased attendance, and reduced discipline problems. Accordingly, interviewed administrators, teachers, and students involved in this study have cited greater student interest and motivation for school and learning as positive immersion effects. Results for quantitative measures, however, were mixed.

Disciplinary Action Reports for the 2005-06 school year showed that immersion students had proportionately fewer behavioral and disciplinary problems than their counterparts in control schools (ES = 0.14 and 0.16 for Cohorts 1 and 2, respectively). Conversely, surveys of students' school satisfaction showed no significant differences between immersion and control students' satisfaction with the kinds of work they do in classes or with the relevance of their schoolwork. Unexpectedly, technology immersion had a significantly negative effect on school attendance. For Cohort 1 students, school attendance rates declined across years, and by the end of seventh grade, the estimated average attendance rate for economically advantaged immersion students was 95.9% compared to 96.4% for control students (rates were lower for disadvantaged students). Results for Cohort 2 students, similarly, showed statistically significant but small differences in attendance rates favoring students in control schools (ES = 0.07).

Effects of Immersion on Academic Achievement

Technology immersion's ultimate goal is increasing students' achievement in core academic subjects as measured by state assessments. For analyses reported below, students' TAKS scale scores were standardized and then normalized as *T* scores with a mean of 50 and a standard deviation of 10.

Technology immersion had no statistically significant effect on Cohort 1, seventh graders' achievement in reading, mathematics, or writing. For Cohort 1 students, we used three-level HLM growth models to estimate mean rates of change in TAKS reading and mathematics scores and a two-level HLM model to estimate the effects of immersion on TAKS writing scores.

- **Reading.** Controlling for student and school poverty, there was no significant effect of immersion on students' growth rate for TAKS reading. The immersion effect was positive but not by a statistically significant margin. Economically disadvantaged students in both immersion and control schools grew in reading achievement at a significantly faster rate than their more advantaged peers. Combined with the positive immersion result, this yielded a positive boost in reading achievement for disadvantaged immersion students.
- **Mathematics.** After controls for student and school poverty, there was no significant effect of immersion on students' growth rate for TAKS mathematics. The immersion effect was positive but not by a statistically significant margin. In contrast to reading, economically disadvantaged students at both immersion and control schools grew in mathematics achievement at a significantly slower rate than their more advantaged peers.

- **Writing.** After adjusting for Cohort 1 students' initial TAKS writing scores (as fourth graders in 2003), student demographic characteristics, and school poverty, there was no statistically significant difference in the 2006 writing scores for students in immersion and control schools. The immersion effect was negative but not by a statistically significant margin.

Technology immersion had no statistically significant effect on Cohort 2, sixth graders' reading achievement. However, immersion had a significantly positive effect on mathematics scores for higher achieving students. We analyzed the effects of immersion on Cohort 2 students' TAKS reading and mathematics scores using two-level HLM models.

- **Reading.** Controlling for students' prior achievement (as fifth graders in 2005), demographic characteristics, and school poverty, there was no statistically significant difference in the 2006 TAKS reading scores for students in immersion and control schools. The immersion effect on reading was positive but not by a statistically significant margin.
- **Mathematics.** After controls for students' prior achievement (as fifth graders in 2005), demographic characteristics, and school poverty, there was no overall significant difference between immersion and control students' TAKS mathematics scores. The immersion effect was positive but not by a statistically significant margin. However, there was a statistically significant immersion effect on mathematics achievement that acted through students' pretest scores. Other factors being equal, having higher pretest scores predicted larger gaps in 2006 math scores favoring immersion students. Thus, immersion had a significantly positive effect on mathematics achievement for higher achieving sixth graders.

Second-year achievement trends generally favored technology immersion schools. Although TAKS scores for immersion and control students usually did not differ by statistically significant margins in the second year, noteworthy achievement trends emerged. In the first project year, TAKS reading and mathematics achievement trends favored control schools. Conversely, in the second year, immersion schools had more positive achievement trends than control schools across *both* Cohorts 1 and 2 and for *both* reading and mathematics subject areas. Outcomes for TAKS writing, in contrast, favored students in control schools. The analysis of writing achievement, however, differed from other subject areas in the wider span of time between the pretest (4th grade) and posttest (7th grade). The testing mode for writing could also have affected outcomes. Immersion students who regularly use word processors for writing may be at a disadvantage when completing a writing assessment in traditional paper-and-pencil format.

Second-year findings provide formative evaluation outcomes. The evaluation of technology immersion is a four-year, longitudinal study, and findings from the second year provide preliminary outcomes. In designing the study, we thought that some effects might emerge during early implementation, but we also believed that changes in longer term outcomes, such as student achievement, might require at least three years to surface (i.e., time for Cohort 1 students to progress from sixth to eighth grade). Additionally, outcomes so far have focused mainly on TAKS reading and mathematics. In the third year, Cohort 1, eighth graders will complete TAKS social studies and science assessments. Thus, outcomes will be available for each of the core-subject areas.

Moreover, while student achievement results as measured by TAKS scores are extremely important, there are other outcomes for immersion students that may contribute to their long-term success. Certainly, technology immersion has narrowed the technology equity gap for economically disadvantaged students. Many students who previously had no technology in their homes are becoming computer literate through their experiences with laptops. Administrators, teachers, and students alike believe that middle school students at immersion schools are better prepared for future educational and workforce requirements and for 21st Century expectations, such as communication skills, and information and media literacy. In the sections to follow, we describe how the generally low levels of implementation may have contributed to second-year results.

Nature of Second-Year Implementation

Most of the middle schools struggled in the second year to implement the prescribed components of technology immersion. Full implementation of the 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. The Implementation Index, a composite campus score measuring the strength of immersion components, showed that a third of middle schools (6 of 21) attained a stronger presence of components that nearly approximated expected standards (*substantial immersion)*, whereas two-thirds of schools had lower implementation levels (*minimal* to *partial immersion)*. Overall, mean immersion standard scores (ranging from 2.48 to 3.06) indicated that supports for immersion generally failed to meet full implementation standards (3.50 to 4.00). With mainly low-to-moderate supports, the average levels of Classroom Immersion (2.48) and Student Access and Use (2.17) were below expectations. Major concerns included students' inconsistent use of laptops across classrooms and subject areas, uneven provision of professional development supporting the design of effective technology-infused lessons, and variability in students' access to laptops during the school day and at home.

The strength of professional development and other supports were associated with higher levels of classroom and student immersion. Variability in the quality of professional development provided by schools was a major obstacle to teachers' growth in creating technology-immersed classrooms. While the immersion model requires that a quarter of grant funds be expended for professional development, the design rested largely with individual districts and campuses and their selected technology vendors (mainly Apple or Dell). Our measure of the strength of the campus professional development component was significantly correlated with teachers' reported levels of classroom immersion. Leadership for immersion also emerged as an important factor in advancing change. Principals appeared to influence teachers' attitudes toward technology through their provision of supports for changed practice. Similarly, students' access to and use of technology for learning was significantly related to their teachers' greater involvement in professional development and the strength of other school supports for immersion.

A continuing challenge in the second year was the consistent provision of laptops for students both within and outside of school. Student laptop access varied widely both across and within schools. The average number of laptop access days reported by students ranged from 42 to 178 days, with only a few campuses achieving full access (the targeted 170 to 180 days per student). Student laptop access was limited by factors such as disciplinary infractions, technical issues, time for repairs, and in a few cases, parent resistance. Additionally, some immersion schools allowed students to have unlimited access to laptops outside of the school day, while others restricted students' out-of-school access to a series of days or to laptop check-outs for teacher-assigned schoolwork. Overall, laptops' potential influence on learning varied across students and schools.

Schools with a greater proportion of economically disadvantaged students had lower implementation levels. Schools with larger concentrations of student poverty had significantly lower levels of implementation. Accordingly, teachers at these schools grew in proficiency and created immersed classrooms at significantly slower rates than teachers in more advantaged schools. Schools serving predominantly disadvantaged and often low-performing student populations faced special challenges in implementing a project requiring profound school and classroom change.

1. Introduction

The Technology Immersion Pilot (TIP) sets forth a vision for technology immersion in Texas public schools. The Texas Education Agency (TEA) originally directed more than $14.5 million in federal Title II, Part D monies toward funding a wireless learning environment for high-need middle schools through a competitive grant process. A concurrent research project funded by a federal Evaluating State Educational Technology Programs grant is evaluating whether student achievement improves over time as a result of exposure to technology immersion. The Texas Center for Educational Research (TCER)—a non-profit research organization in Austin—is the TEA's primary partner in this four-year endeavor.

The overarching purpose of the study is 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). Technology immersion encompasses multiple components, including a laptop computer for every middle school student and teacher, wireless access throughout the campus, online curricular and assessment resources, professional development and ongoing pedagogical support for curricular integration of technology resources, and technical support to maintain an immersed campus. The evaluation also aims to examine the relationships that exist among contextual conditions, technology immersion, intervening factors (school, teacher, and student), and student achievement. In the first year, there were 22 experimental and 22 control sites in the study. However, in the second year, two middle schools in one school district (one experimental and one control) were removed from the study due to the devastating effects of Hurricane Rita on the Texas Gulf coast. School buildings were damaged, laptops destroyed, and the school year disrupted. Thus, second-year results are for remaining 21 experimental and 21 control schools.

Theory of Technology Immersion

In recent years, the vision for educational technology endorsed by many educators, leaders, and policymakers has shifted from the use of particular technology 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 technology-infused 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 also believe that educational technology can help students develop the competencies needed for the 21st century. Children who are growing up in the Digital Age must have different competencies, including digital literacy, inventive thinking, and effective communication (CEO Forum, 2001; Lempke, Couglin, Thandani, & Martin, 2003). Correspondingly, there is a growing concern that U.S. schools are not preparing students to succeed in the modern world. Today's graduates must be critical thinkers, problem solvers, and effective communicators who are proficient in core subjects as well as in information and media literacy (Partnership for 21st Century Skills, 2006).

Similarly, Texas has long recognized that the state's success is tied to the provision of opportunities for the Digital Age. Preparing for the 21st century means that Texas students must learn different ways to work with tools, information, and people. The Texas *Long-Range Plan for Technology, 2006-2020*, advances the previous state plan's approach for the integration of technology within schools across four major domains: teaching and learning; educator preparation and development; leadership, administration, and instructional support; and infrastructure for technology (TEA, 2006). Texas Senate Bill 396, enacted during the 2003 Texas legislative session, further defines this comprehensive vision as "technology immersion." Technology immersion calls for the provision of a wireless mobile computing device for each student in a school, the use of technology-based learning resources, training teachers to integrate technology into the classroom, and the provision of support for effective technology use. 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).

Technology Immersion Components

While Texas state statutes provide a general description of technology immersion, TEA staff relied on existing research on educational technology as well as practical wisdom gained through numerous pilot studies and statewide technology initiatives to specify critical components of immersion. The technology immersion model assumes that effective technology use in schools and classrooms requires (a) robust technology access, (b) technical and pedagogical support for implementation, (c) professional development for educators in using technology effectively, and (d) readily available curricular and assessment resources that support the state's curriculum in the core subjects (English language arts, mathematics, science, and social studies).

Robust Access to Technology

The targeted level of technology access in Texas is one-to-one access to Internet-connected multimedia computers in classrooms. Similar to national trends, the Texas ratio of students to instructional computers was 3.5 to 1 in 2006, a slight decrease from the ratio of 3.7 to 1 in 2001. Texas schools also have built their infrastructure for technology. Texas had a 3.4 ratio of students per high-speed Internet-connected computers in 2006 (Education Week, 2007). Despite school-level improvements in technology access across years, a statewide survey conducted in 2002 and baseline data collected for this study in 2004 indicate 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., 2006b). Correspondingly, when Texas middle-school students in 2005 were asked how they found out about websites and new technology and how to use them, only 13% reported that they learned from "teachers or classes in school;" students, instead, indicated they learned from "my friends" (32%) or "I explore on my own" (34%) (NetDay, 2005).

Additionally, inequities in technology access continue to pose challenges for economically disadvantaged and minority students both nationally and in Texas. While access to computers and the Internet in higher and lower poverty schools has narrowed in recent years, the income-related gap persists. Nationally, the rate of at-home computer use among children from families earning less than $20,000 a year was 37% percent compared to 80% or higher for children from families earning $50,000 or more (Trotter, 2007). Thus, low-income students had fewer opportunities than their more advantaged peers to develop effective technology skills and to enhance learning at home. Likewise, minority and economically disadvantaged students in Texas are less often exposed to technology outside of school (Shapley et al., 2002).

As a way to counteract prevailing conditions, technology immersion aims for one-to-one student technology access. The Texas project is not unique in its quest for one-to-one computing. As computer technologies have become more affordable and accessible, large-scale projects have begun to appear with each student in a school, grade level, or classroom receiving his or her own computing device

(Zucker, 2004; Penuel, 2006). Although the technology immersion pilot is similar to other laptop projects in its provision of one-to-one computing, it is unique in its focus on immersing entire schools in technology and simultaneously providing implementation supports.

Technical and Pedagogical Support

Technology immersion also assumes that increased access to and use of technology in schools requires a healthy technical infrastructure and adequate technical and pedagogical support. Schools must have electronic networks that are robust enough to support wireless laptops and digital content. Campus-based technical support is also vital, as many studies emphasize the importance of on-site access to support personnel who are responsible for assisting teachers in learning to use technology, troubleshooting technical problems, and effectively integrating technology into lessons (e.g., CEO Forum, 2001; Ringstaff & Kelley, 2002; Shapley et al., 2002). Studies have found a strong relationship between the provision of quality technology support and teachers' technology use and their changes in use over time (Ronnkvist, Dexter, & Anderson, 2000; National Center for Education Statistics [NCES], 2000). Disparities in access to technology support also emerge. Teachers at low-socioeconomic schools and at smaller schools and districts report less technical and instructional support (Ronnkvist et al., 2000; Shapley et al., 2002). In addition to technical assistance, ongoing professional development and pedagogical support for teachers' efforts to use technology, as discussed below, is crucial. Considering the importance of support for implementation, technology immersion requires that each school provide technical assistance and ongoing pedagogical support.

Professional Development

Technology immersion assumes that technology's potential impact on student learning depends on teachers' opportunities for effective professional development. Research shows that effective professional development should be of appropriate duration, provide ongoing support, be relevant to individual needs, entail active learning, build content knowledge, and contribute to a professional culture (e.g., Hawley & Valli, 1999; Newmann & Associates, 1996; Garet, Porter, Desimone, Birman, & Yoon, 2001). In particular, research shows that professional development activities of longer duration provide richer learning experiences (Garet et al., 2001). For technology, training should be of an adequate length to comprehensively investigate the topics and provide time for practice and experimentation (American Council on Education, 1999; Lewis, et al., 1999; Smerdon, et al., 2000). Evidence shows that when a particular technology use is mastered by teachers over time or promoted through sustained professional development, it is more likely to be incorporated into instruction (Zhao & Frank, 2003).

Professional development also should include follow-up to support teachers as they acquire and implement new skills in the instructional setting (Apple Computer, Inc., 1995; Garet et al., 2001). While structured professional development provides a start, ongoing, campus-based mentoring and coaching is also necessary to help teachers learn try out new technology-based instruction and activities in the classroom (Bradburn & Osborne, 2007; Nugent & Fox, 2007; Sulla, 1999). Effective professional development should also focus on subject-specific content or specific teaching methods. For technology, this means that activities should not just build teachers' basic technology skills but should support their understanding of effective curricular integration methods as well (CEO Forum, 2000, 2001; Denton, Davis, & Strader, 2001; Ringstaff & Kelly, 2002; Web-Based Education Commission, 2000).

Additionally, technology professional development should not be isolated but should be part of broader professional growth initiatives in schools (Fullan & Hargreaves, 1996; Mann, Shakeshaft, Becker, & Kottkamp, 1999). 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). Through collective experiences, teachers develop shared norms and values that together reinforce new practices (Newmann & Associates, 1996). A leadership development component is also vital. Research points consistently to the important role of school leaders in successful implementation of technology (Bradburn & Osborne, 2007; Johnston & Cooley, 2001; Pitler, 2005).

Teacher involvement in technology-related professional development also has been associated with positive outcomes. Teachers who participate in professional development more often use technology for instructional purposes (Becker, 1999; Kanaya, Light, & Culp, 2005; Martin & Shulman, 2006; NCES, 2002; Wenglinsky, 1998). Moreover, as training participation increases, teacher reports of feeling well prepared to use technology for instruction increase as well (Smerdon et al., 2000).

Curricular and Assessment Resources

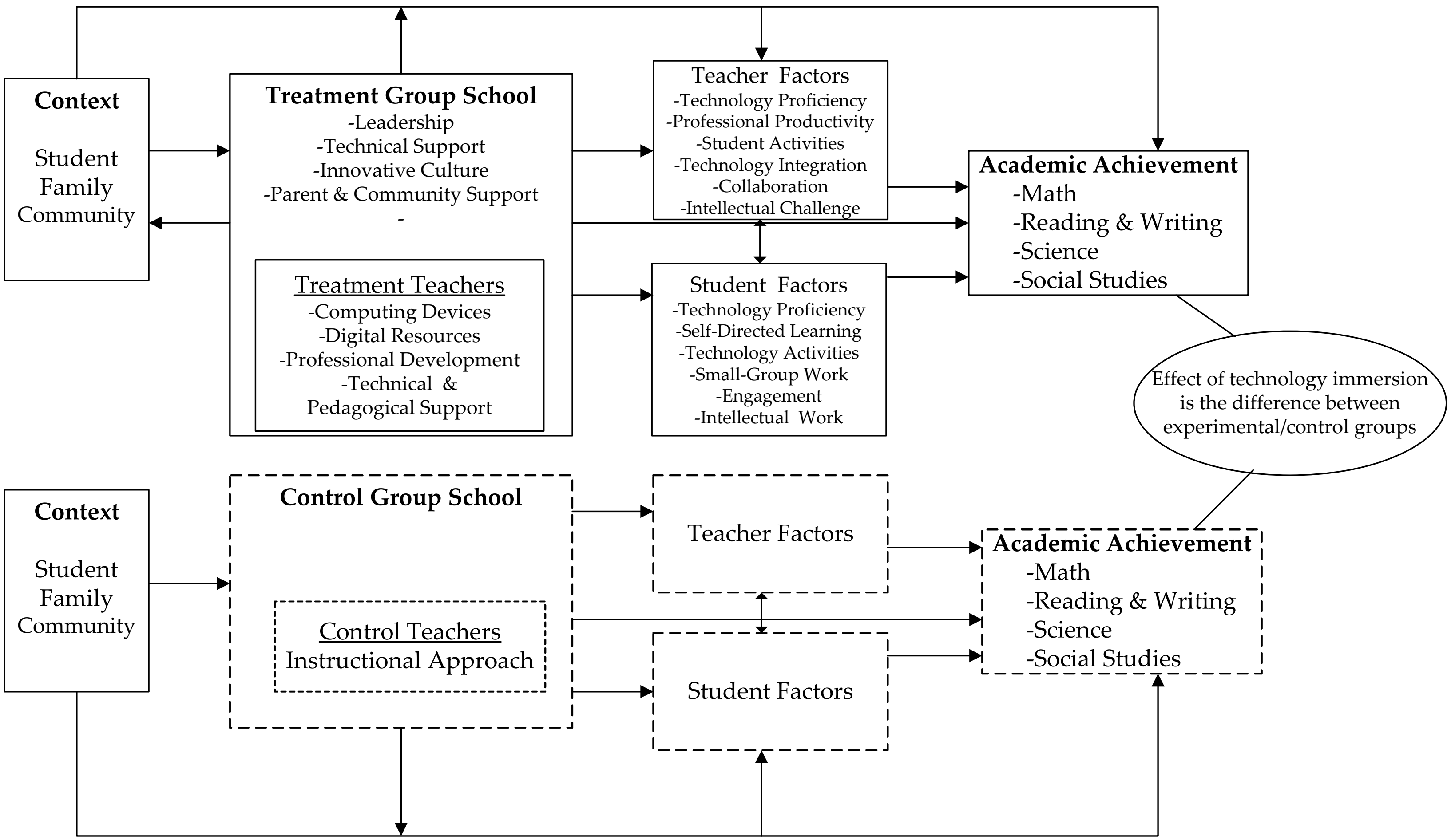
Technology's impact on student academic achievement in an immersed school hinges on the availability of instructional and learning resources that support the state's curriculum. Immersion resources include productivity, communication, and presentation software that allow students and educators to use wireless laptops as a tool for teaching, learning, communication, and productivity. Additionally, digital resources (e.g., online, CD-ROMS, stored on local networks) provide a means to support more engaged, thoughtful, relevant, and personalized learning activities for students. Interactive technologies allow students to build new knowledge by doing, receiving feedback, and refining their understanding. Technologies may also help students to acquire more information, visualize difficult-to-understand concepts, and advance understanding. Immersion resources, thus, provide a means to extend, supplement, or enhance the state's curriculum. In addition to instructional resources, technology immersion provides online formative assessments that allow teachers to diagnose students' strengths and needs and assess progress toward curricular mastery.

Implementing digital resources aligned with the Texas curriculum is expected to modify existing instructional practices. Yet, as others have pointed out, the availability of wireless laptops and digital resources may not improve student learning and achievement if teachers fail to use resources or simply provide the same kinds of lessons and assignments electronically instead of using new technologies to transform students' learning experiences (Means, Haertel, & Moses, 2003).

Theoretical Framework for Technology Immersion

The *Theoretical Framework for Technology Immersion* guides the evaluation (see Figure 1.1). The experimental design, as illustrated in the framework, allows an estimate of the effects of the intervention, which is the difference between the experimental and control groups. The framework also postulates a linear sequence of causal relationships. Program implementation comes first. Experimental schools are to be "immersed" in technology through the introduction of technology immersion 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 expect school-level improvements in measures of classroom technology integration, technical support, innovative culture (teacher support or buy-in), and parent and community support. Leadership drives progress toward full immersion.

Figure 1.1. Theoretical Framework for Technology Immersion



An improved school environment for technology should lead to teachers who have greater technology proficiency, use technology more often for their own professional productivity, collaborate more with their peers, have students use technology more and in new ways in their classrooms, and use laptops and digital resources to increase the intellectual challenge of lessons. In turn, improved school and classroom conditions should lead students to greater technology proficiency and personal self-direction, more frequent classroom technology activities and opportunities for peer collaboration, 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 study's theoretical framework has guided the evaluation design as well as the design of data collection procedures and measures. The research literature underpinning the framework is included in Appendix A.

Study Questions

The evaluation of technology immersion employs a quasi-experimental research design with middle schools assigned to either treatment or control groups. In the second year, researchers answered the following questions:

- How is technology immersion implemented, and what factors are associated with higher implementation levels?
- What is the effect of technology immersion on teachers and teaching?
- What is the effect of technology immersion on students and learning? and
- Does technology immersion affect student achievement?

This report concentrates on information gathered from the participating middle school campuses during the 2005-06 school year. Data collection involved a mix of qualitative and quantitative data sources. Researchers conducted site visits in each of the middle schools in fall 2004 and again in spring of 2005 and 2006. For this report, we concentrate on data gathered through observations in a sample of sixth- and seventh-grade classrooms. Additional measures include annual online teacher surveys and student paper-and-pencil surveys. We also gathered school and student data from the Texas Public Education Information Management System (PEIMS), the Academic Excellence Indicator System (AEIS), and data on student disciplinary actions from schools.

Organization of the Report

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 section also establishes the purpose for the study and the research questions addressed.
- *Chapter 2, Methodology*, presents information on the evaluation design, characteristics of immersion and control schools, study limitations, study participants, data collection methods, and data analysis procedures.

- *Chapter 3, Technology Immersion—Second-Year Implementation,* describes progress toward implementation in the second year and factors associated with higher implementation.
- *Chapter 4, Effects of Technology Immersion on Teachers and Teaching*, presents findings on the effects of immersion on teacher variables, including technology proficiency, professional productivity, teachers' ideologies, students' classroom activities with technology, collaboration with peers, 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' self-perceptions of their technology proficiency, self-directed learning, and school satisfaction; students' experiences with technology; and students' engagement.
- *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, and writing assessments for Cohorts 1 and 2 students.
- *Chapter 7, Conclusions and Implications*. The final section presents the major findings from the study and discusses the implications of outcomes.

2. Methodology

Evaluation Design

The evaluation design is quasi-experimental with a carefully matched comparison group. The design aims to approximate a randomly assigned control group by matching immersion schools with non-immersion schools possessing similar pre-intervention characteristics. For this study, 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. The TIP grants targeted high-need schools, thus nearly 70% of students in the study come from economically disadvantaged backgrounds, with many schools in rural or isolated locations. Students are ethnically diverse, roughly 58% Hispanic and 7% African American. As noted in the introduction, two middle schools from one district (one treatment and one control) were removed from the study in the second year due to the damaging effects of Hurricane Rita. Therefore, second-year results are for the remaining 21 treatment and 21 control schools. A re-analysis of baseline data for the new sample revealed that school and student characteristics generally were unchanged and differences between groups remained statistically insignificant. Thus, the study's research design appears sound.

Treatment Sample

In spring 2004, the TEA released a series of Requests for Applications (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 by five readers and scores 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.

Control Sample

The selection of control campuses first involved the generation of a pool of grades 6-8 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. Each control school receives $50,000 annually for study participation, with 25% of funds earmarked for professional development as required by Title II, Part D guidelines.

Characteristics of Participating Schools

The schools participating in the study are compared in Table 2.1. 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 2.1. 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.

Information in Table 2.2 compares the baseline characteristics of immersion and control schools. Results for *t*-tests show that the percentages of economically disadvantaged, minority, English as a second language (ESL), and special education students are statistically equivalent across the treatment and control schools. Likewise, results for student enrollment, mobility, and TAKS passing rates show no significant differences. Consequently, the treatment and control schools are sufficiently well matched on key demographic and academic performance measures. Moreover, both treatment and control samples include a range of campus and district enrollments and schools from diverse regions of the state. In these respects, the sample selection process and matching procedures appear to have produced a sample of schools with good internal validity, in that there are no large, statistically significant treatment-control differences. Still, the tendency for immersion schools to enroll greater proportions of minority and economically disadvantaged students may be important considering known links between disadvantaged status and lower achievement.

Table 2.2. Comparison of Baseline Characteristics: Technology Immersion (*N* = 21) and Control Schools (*N* = 21)

Variable	Condition	Mean	*SD*	95% Confidence Interval for Difference		
				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 experimental and one control) were excluded from the groups in the second year.

Table 2.3 provides campus-level data for each of the 42 schools included in the study. Again, data in the table show that the treatment and control schools are reasonably well matched on baseline characteristics. Middle schools are highly concentrated in rural and very small districts across the state. Still, 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.

The primary limitation of the study is external validity—the extent to which the results of an experiment can be generalized from the specific sample to the general population. Schools eligible to become part of the treatment group were limited to those serving children from families living in poverty[1] and 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.

The majority of students in the sample are economically disadvantaged. The percentage of sample students who qualify for federal free or reduced-price lunch exceeds the state average for middle schools (67% vs. 51%). The sample also is substantially more Hispanic and less White and African American than state middle-school students as a whole. 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% vs. 46%) compared to the state averages.

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

Table 2.3. Characteristics of Technology Immersion and Matched Control Schools

Campus	Location			Students							
	District	District Enroll-ment	Community Type	Grades 6, 7, 8 Number	White (%)	African American (%)	Hispanic (%)	ESL (%)	Special Ed (%)	Eco Disadv (%)	Mobility (%)
Immersion											
Fruitvale Middle	Fruitvale	448	Rural	100	93.0	1.0	6.0	1.0	29.0	62.0	14.6
McLeod Middle	McLeod	478	Rural	138	93.5	4.3	1.4	0.0	17.4	44.2	14.6
Monte Alto Middle	Monte Alto	501	Rural	151	4.0	0.0	96.0	19.2	13.9	90.1	14.3
De La Paz Middle	Riviera	511	Rural	123	35.0	0.8	63.4	6.5	17.1	62.6	12.9
Charlotte Junior High	Charlotte	514	Rural	118	16.9	0.0	83.1	1.7	17.8	66.1	12.0
Memphis Middle	Memphis	530	Rural	124	46.8	12.9	40.3	12.9	19.4	65.3	14.6
Morton Junior High	Morton	540	Rural	117	23.9	11.1	64.1	5.1	9.4	78.6	12.2
Post Middle	Post	986	Non-metro: Stable	207	45.4	6.8	46.9	0.0	14.5	56.5	27.1
Floydada Junior High	Floydada	1,041	Non-metro: Stable	240	32.5	4.2	63.3	11.3	10.8	63.3	15.1
Newton Middle	Newton	1,307	Non-metro: Stable	299	53.8	41.8	2.0	0.3	18.1	57.9	18.8
Dublin Middle	Dublin	1,331	Non-metro: Stable	309	53.7	0.3	45.3	5.2	12.6	64.4	17.2
Brady Middle	Brady	1,385	Non-metro: Stable	295	54.9	3.1	41	1.4	19.3	62.0	14.5
Franco Middle	Presidio	1,516	Non-metro: Stable	341	0.6	0.0	99.1	38.1	10.6	93.5	15.0
Bernarda Junior High	San Diego	1,542	Non-metro: Stable	354	1.1	0.3	98.6	11.9	13.8	82.5	11.5
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 2.3. Characteristics of Technology Immersion and Matched Control Schools (*Continued*)

Campus	Location			Students							
	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).

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) and are concentrated in larger districts (11,575 students enrolled, on average, vs. 3,672 in sample schools). Thus, compared to the state overall, sample schools and the districts they reside in are smaller and serve more economically disadvantaged and Hispanic students. Differences 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 dollars required to support one-to-one technology in larger middle schools.

Participants

Students

Table 2.4 shows that four groups or cohorts of students will be followed in this study, with Cohort 1 followed for four years, Cohort 2 for three years, Cohort 3 for two years, and Cohort 4 for one year. Data collection activities in 2005-06 centered on Cohorts 1 and 2.

- Cohort 1 (seventh graders) included a total of 5,538 students, with 2,627 students enrolled at treatment campuses and 2,911 at control campuses; and
- Cohort 2 (sixth graders) included a total of 5,507 students, with 2,685 students enrolled at treatment campuses and 2,822 at control campuses.

Table 2.4. Student Cohorts by School Year and Grade

	Middle School			High School
Year	Grade 6	Grade 7	Grade 8	Grade 9
2004-05	Cohort 1			
2005-06	**Cohort 2**	**Cohort 1**		
2006-07	Cohort 3	Cohort 2	Cohort 1	
2007-08	Cohort 4	Cohort 3	Cohort 2	Cohort 1

Note. Bold text denotes the current evaluation year.

Table 2.5 shows that about three-fourths of seventh graders (Cohort 1) and sixth graders (Cohort 2) are economically disadvantaged. Comparison groups have nearly equal 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.

Table 2.5. Demographic Characteristics of Students: 2005-06

	Cohort 1 (Grade 7)				Cohort 2 (Grade 6)			
	Immersion		Control		Immersion		Control	
Characteristic	*N*	Percent	*N*	Percent	*N*	Percent	*N*	Percent
Enrollment	2,627	--	2.911	--	2,685	--	2,822	--
Economic disadvantage	1,972	75.1	2.135	73.4	2,044	76.1	2,064	73.3
Ethnicity								
African American	161	6.1	213	7.3	163	6.1	232	8.2
Hispanic	1,900	72.4	1,948	66.9	1,960	73.0	1,900	67.3
White	537	20.4	739	25.4	526	19.6	677	24.0
Other	28	1.1	11	0.4	35	1.3	13	0.5
Limited English prof.	611	23.3	460	15.8	811	30.2	523	18.6
Gender								
Female	1,270	48.3	1,413	48.5	1,341	49.9	1,346	47.7
Male	1,357	51.7	1,498	51.5	1,344	50.1	1,476	52.3

Source: Spring 2006 student database collected from 21 treatment and 21 control campuses.

Teachers

During the 2005-06 school year, 1,257 teachers participated in the study (604 at treatment campuses and 653 at control campuses). Teachers in comparison groups are remarkably similar in terms of gender, ethnicity, advanced degrees, and average teaching experience. The number of teachers declined in the second year due to the exclusion of two campuses.

Table 2.6. Demographic Characteristics of Teachers

	2004-05		2005-06	
Characteristic	Immersion *N=22*	Control *N=22*	Immersion *N=21*	Control *N=21*
Number of teachers	622	682	604	653
% Female	65.4	68.8	63.4	68.3
% Minority	42.4	35.3	44.9	43.3
% African American	7.8	7.5	2.8	4.8
% Hispanic	32.2	26.3	40.4	37.3
% White	57.6	64.7	55.1	56.7
% with no degree	0.0	2.0	0.2	0.3
% with advanced degree	21.7	22.2	21.2	18.3
Average years of teaching experience	10.9	11.4	10.6	11.5

Note. The total number of teachers was 1,304 in 2004-05 and 1,257 in 2005-06

Data Collection

Data collection for the project began in August 2004. As Table 2.7 illustrates, researchers conducted site visits in each of the middle schools in fall 2004 and spring of 2005 and 2006. Additional measures, administered as pre-tests in fall and post-tests in spring, included teacher online surveys and student paper-and-pencil surveys. Additionally, we gathered school and student demographic, attendance, and achievement data from the Texas Public Education Information Management System (PEIMS) and Academic Excellence Indicator System (AEIS). In spring 2005 and 2006, individual middle schools submitted student-level data on disciplinary actions.

Table 2.7. Time Frame for Data Collection: 2004-05 and 2005-06

	2004-05		2005-06	
	Fall 2004	Spring 2005	Fall 2005	Spring 2006
Site visits (classroom observations)	X	X		X
Teacher Survey (all teachers)	X	X		X
Teacher Survey (new teachers)			X	
Student Survey (Cohort 1)	X	X		X
Student Survey (Cohort 2)			X	X
Style of Learning Inventory (Cohort 1)	X	X		X
Style of Learning Inventory (Cohort 2)			X	X
Texas Assessment of Academic Skills (TAKS)		X		X
Attendance		X		X
Disciplinary actions		X		X

Note. Data collection for 22 treatment and 22 control schools in 2004-05 and 21 treatment and 21 control schools in 2005-06. TAKS and attendance data also were collected for spring 2003 and spring 2004.

Measures

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

Teacher Survey

Immersion and control teachers completed an online technology survey in fall 2004 (September to October) and spring 2005 (April to May). Additionally, in fall 2005 (September to October), teachers new to the schools completed the survey, and in spring 2006 (April to May), all teachers completed surveys. 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).

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*). Item analysis using 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 0.94.

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 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). Cronbach's alpha for scales ranged from 0.70 to 0.99.

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

Cohort 1 students completed paper-and-pencil questionnaires measuring their technology proficiency and use in fall 2004 and spring 2005 as sixth graders, and as seventh graders in spring 2006. Additionally, they completed the *Style of Learning Inventory* (*SLI*) during the same time periods. The *SLI*, a paper-and-pencil questionnaire measuring student self-directed learning (i.e., self-generated behaviors oriented toward the attainment of learning goals), was administered as a baseline measure in fall 2004 and as a post-measure in spring of 2005 and 2006. Cohort 2 students (sixth graders) completed technology surveys in fall 2005 and spring 2006; they completed the *SLI* during the same two time periods.

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 2.7. Response rates were in the 80% to 90% range across time periods, and there were only slight differences in response rates between cohorts and comparison groups.

Table 2.7. Student Technology Survey Response Rates: 2004-05 and 2005-06

	Fall 2004		Spring 2005		Fall 2005		Spring 2006	
	N	*%*	*N*	*%*	*N*	*%*	*N*	*%*
Cohort 1								
Treatment	2,319	90	2,053	80	--	--	2,291	87
Control	2,505	84	2,485	83	--	--	2,544	87
All	4,824	87	4,538	82	--	--	4,835	87
Cohort 2								
Treatment	--	--	--	--	2,209	84	2,379	89
Control	--	--	--	--	2,405	86	2,452	87
All	--	--	--	--	4,614	85	4,831	88

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)*. A factor analysis of fall 2004 *SLI* data revealed low internal consistency of scales and groupings. Since no scales or groupings had sufficient reliability ($\alpha = 0.18$ to 0.52), analyses were limited to the *SLI* total score ($\alpha = 0.89$).

Table 2.8 summarizes *SLI* response rates. Responses ranged from 77% to 82% across time periods. With the exception of the spring 2005 *SLI* administration, there were only slight differences in response rates between cohorts or comparison groups.

Table 2.8. Style of Learning Inventory Response Rates: 2004-05 and 2005-06

	Fall 2004		Spring 2005		Fall 2005		Spring 2006	
	N	%	*N*	%	*N*	%	*N*	%
Cohort 1								
Treatment	2,142	83	2,174	85	--	--	2,116	80
Control	2,442	82	2,120	71	--	--	2,387	81
All	4,584	82	4,294	77	--	--	4,503	81
Cohort 2								
Treatment	--	--	--	--	2,115	80	2,198	82
Control	--	--	--	--	2,265	81	2,228	79
All	--	--	--	--	4,380	80	4,426	80

Observation of Teaching and Learning

Researchers conducted fall 2004 classroom observations in a sample of Cohort 1, sixth-grade, core-subject classrooms (reading/English language arts, mathematics, science, and social studies). Spring 2005 observations also focused on Cohort 1 students' classrooms. In spring 2006, we expanded the sample to include seventh-grade teachers of Cohort 1 students and sixth-grade teachers of Cohort 2 students.

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 dimensions of intellectual challenge on a 5-point scale: Higher Order Thinking, Disciplined Inquiry, Substantive Conversation, and Value Beyond School. An aggregate score across three of the scales was used as an overall measure of the Intellectual Challenge. We excluded the Substantive Conversation scale because ratings were biased by classroom organization. Classes with teacher-directed instruction provided better opportunities to document the nature of substantive conversations.

Number of observations. During fall 2004, researchers conducted observations at 22 middle schools (11 treatment and 11 control). In spring of 2005 and 2006, we expanded observations to all of the middle schools. In fall, researchers observed 128 classrooms (64 treatment and 64 control); in spring 2005, we conducted follow-up observations, when possible, in the same classrooms. Altogether, we observed 240 classrooms (117 treatment and 123 control) in spring 2005. The following year (spring 2006), we observed 243 classrooms (130 treatment and 113 control). These observations included a nearly equal mix of sixth- and seventh-grade classrooms. At small campuses, researchers observed nearly all core-subject teachers. For larger campuses, we observed at least eight classrooms (about half of core teachers).

Training procedures. Prior to site visits in fall 2004 and spring of 2005 and 2006, 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.

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 observer reliability (i.e., the percentage of agreement on ratings from paired observations). Additionally, paired observations supported the use of Many-facets Rasch Analysis (MFRA) to adjust scale scores on the Intellectual Challenge factor for the relative difficulty of each scale and the relative severity (or leniency) of each observer.

Inter-rater agreement. Inter-rater agreement has been established for the Intellectual Challenge component of the classroom observation instrument. For this element, observers used 5-point rating scales to measure four dimensions of a lessons' intellectual demand (Higher-Order Thinking, Disciplined Inquiry, Substantive Conversation, and Value Beyond School). Observer reliability on these scales was measured 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 of 2005 and 2006. Exact agreement was 63% and 62%, respectively, and 89% and 93% when ratings varied by one scale point.

An overall measure of Intellectual Challenge for each teacher was constructed using Many-Facets Rasch Analysis (MFRA). The quality of instruction measure is an aggregate score across three scales (Higher Order Thinking, Disciplined Inquiry, and Value Beyond School). The measure is adjusted for the relative difficulty of each scale and the relative severity (or leniency) of each observer. MFRA produces several fit statistics that can be used to measure each observer's intrarater reliability or internal consistency. One of these, observer infit, weights each standardized residual by its variance and is more sensitive to unexpected patterns of small residuals. A second statistic, observer outfit, is an unweighted mean-square residual sensitive to outlying residuals (Linacre, 2004). There is no fixed rule for setting upper and lower limits for theses fit statistics. "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, spring 2005, and spring 2006, respectively, resulted in observer infit values from 0.61 to 1.34, 0.61 to 1.34, and 0.43 to 1.59, and observer outfit values from 0.62 to 1.20, 0.62 to 1.20, and 0.40 to 1.67. While the spring 2006 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. As a whole, no unusual rating patterns appeared to be present in the 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]

Cohort 1 students completed the TAKS reading and mathematics assessments as a pretest in 2004 (5th grade) and as posttests in 2005 (6th grade) and 2006 (7th grade). Cohort 1 students completed the TAKS writing assessment in 2003 (4th grade) and 2006 (7th grade). Cohort 2 students completed the TAKS reading and mathematics assessments as pretests in 2005 (5th grade) and as posttests in 2006 (6th grade).

At grades 6 and 7, 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. TAKS mathematics at grades 6 and 7 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. 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.

School Attendance and Disciplinary Actions

Post-measures of student attendance for Cohort 1 came from PEIMS data for the 2004-05 and 2005-06 school years; attendance data for the previous two school years (2002-03 and 2003-04) served as pre-measures. Similarly, for Cohort 2, student attendance data for 2005-06 provided a post-measure while data for two school years (2003-04 and 2004-05) served as pre-measures. Additionally, individual campuses submitted data for student disciplinary actions taken during the 2005-06 school year. Data files included an indicator for the total number of Disciplinary Action Reports (PEIMS 425 records) reported for each student (Cohorts 1 and 2) during the school year.

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

3. Technology Immersion—Second-Year Implementation

Understanding whether or not an intervention has an effect on desired outcomes first requires an examination of the extent to which the intervention (in this case technology immersion) has been implemented as designed. Accordingly, 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 measurement of implementation across sites. Next, we summarize research showing the important role of implementation in explaining project outcomes and describe our approach to measuring the level and quality of implementation of technology immersion. Finally, findings are presented on the fidelity of second-year implementation at the 21 treatment campuses, with information derived from data collected during the 2005-06 school year.

Defining Technology Immersion

As a way to ensure consistent interpretation of technology immersion and comparability across sites, 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). Although state statute gives a general description of technology immersion, the concept and its component parts were defined operationally to foster continuity across treatment campuses. Vendor applicants to the RFQ had to include the following six components in their plan:

- A wireless mobile computing device for each educator and student on an immersed campus to ensure on-demand access to technology;
- Productivity, communication, and presentation software for use as 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 a competitive application and 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]). Prices for technology immersion packages varied according to the numbers of students and teachers, the type of laptop computer, and the vendor provider. Package costs ranged from about $1,100 to $1,600 per student. Of the 21 immersion sites studied in the second year, 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.

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	Classroom Connect
Technical and pedagogical support	Apple, Campus/District	Dell, Campus/District	ESC 1, Campus/District

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) that is provided free of charge by the state.

Professional Development

Each immersion package includes a different professional development provider. Apple uses its own professional development model, whereas the Dell package relies on *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.

Association of Implementation and Outcomes

The study of large-scale educational reforms and organizational change has shown that the level and quality of implementation largely determines the achievement of desired outcomes (Berman & McLaughlin, 1978; Borman, Hewes, Overman, & Brown, 2003; Datnow, Borman, & Stringfield, 2000; Fullan & Stieglbauer, 1991). Studies of technology innovations, likewise, reveal that ineffective implementation undermines prospects for changes in student learning opportunities and academic outcomes (Cuban, 2001; Cuban, Kirkpatrick, & Peck, 2001). Lessons learned from earlier studies of school reform led Desimone to conclude: "…it is first necessary to measure the degree of implementation before assessing outcomes and attempting to attribute them to a specific program" (2002, p. 437).

Building on prior experience and research, the focus of school improvement has shifted recently from program-centered reforms to initiatives that focus on changing the whole school as a way to foster improved student outcomes through changes in teaching and learning. Increasing numbers of schools, particularly low performing ones, have undertaken comprehensive school reform. Spurred by the availability of federal funds and the No Child Left Behind Act of 2001, hundreds of comprehensive school reform (CSR) models have been developed and implemented in schools. As a result, the nature of model implementation and the school change process have been studied widely. Although technology immersion and CSR models are not identical, they share the common focus of changing the whole school, including changes to the curriculum and delivery of instruction. Thus, past research contributes to a clearer understanding of current implementation findings.

Evidence from a meta-analysis of CSR achievement effects shows that implementation counts. Using the best available measure of implementation—the number of years a CSR model was implemented in a school—researchers found an increasing effect on achievement outcomes associated with a greater number of years of implementation. The CSR effect size was relatively strong in the first year (0.17), but there was a tendency for new initiatives to weaken in the second, third, and fourth years. On the other hand, schools that implemented models for five or more years showed achievement advantages nearly twice as large (Borman et al., 2003; Borman, 2005). These long-term effects, however, may be influenced by the large proportion of schools (up to one third) that discontinued use of CSR models within the first few years, and consequently, were excluded from longitudinal analyses (Borman, 2005).

More recent, in-depth studies of CSR model implementation demonstrate that achieving quality implementation is challenging. Studies involving hundreds of CSR schools revealed that none of the schools had fully implemented all components of the models they had adopted. Schools appeared to implement components selectively (Kurki, Aladjen, & Carter, 2005). And notably, schools had more difficulty following instructional practices prescribed by their model and practices aimed at increasing parental involvement in school affairs (Vernez, Karam, Mariano, & DeMartini, 2006). In these studies, higher levels of implementation were associated with higher levels of support (e.g., principal leadership, teachers' commitment, model developer support, professional development).

Findings regarding the influence of contextual variables (school size or student characteristics) were mixed as were results regarding the improvement of implementation over time. Kurki, Aladjen, and Carter (2005) cited increased implementation for most indicators between the first and third year, whereas Vernez et al. (2006) found that the first year or so, for the most part, determined the degree of implementation, with levels remaining fairly constant across three years. It remains to be determined whether implementation as measured in these studies links to student academic outcomes. Still, findings as a whole, point to the crucial need to measure the extent of implementation before drawing conclusions about the effectiveness of technology immersion.

Measuring Implementation Fidelity

Measurement of second-year implementation of technology immersion builds upon research conducted during the first project year. Direction for the refinement of the technology immersion model and its measurement came from first-year reports describing the nature of project implementation and factors that promoted or impeded success,[1] reviews of immersion packages, and discussions with project and vendor staffs. As in the first year, implementation is measured as the fidelity with which technology immersion *components* and related *elements* attain an envisioned "ideal." This approach involves gathering extensive data on immersion components at each of the treatment campuses and comparing campus-to-campus variations with the vision for "full" implementation.

In contrast to the first year, we adopted a two-part approach in the second year. First, we used indicators to describe each campus' progress on a 4-step scale toward immersion standards. Rating scales for components and related elements identify 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). Both the immersion standard scores and implementation indices are 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. Scores for components and their elements come from surveys of teachers (N=560, including 318 core-subject teachers) and students (N=7,022) at 21 treatment schools.

Table 3.2 provides descriptions of the technology immersion indicators that contributed to both the immersion standard scores and implementation indices. Appendix C provides additional technical detail on the measurement of implementation fidelity and scoring rubrics that describe the four levels of immersion for immersion components and their related elements.

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[1] Shapley et al. (2006a). *Evaluation of the Texas Technology Immersion Pilot: First-Year Results.* Austin, TX: Texas Center for Educational Research. Shapley et al. (2006b). *Evaluation of the Texas Technology Immersion Pilot: An Analysis of Baseline Conditions and First-Year Implementation of Technology Immersion in Middle Schools.* Austin, TX: Texas Center for Educational Research.

Table 3.2. Description of Implementation Indicators for Technology Immersion

Leadership
To what extent do teachers indicate that the principal establishes a clear vision and expectations, encourages integration, provides supports, and involves staff in making decisions about instructional technology.
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.
To what extent do teachers believe that parents and the surrounding community support the school's efforts with technology.
To what extent do teachers indicate that technical problems with computers, Internet access, repairs, and material availability pose barriers to technology immersion.
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.
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).
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 C 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,[2] 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:

[2] Vernez, G., Karam, R., Mariano, L.T., & DeMartini, C. (2006). *Evaluating Comprehensive School Reform Models at Scale: Focus on Implementation*. Santa Monica, CA: RAND.

- **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), and
- an overall implementation score for each school (Implementation Index). [3]

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 and their teachers implemented components, including those relevant to classroom immersion practices and students' technology access and use. We first present campus-level results for the Implementation Index (*z* score), which provides an overall measure of technology immersion, and then use implementation standards (measured at four levels) to describe the level of implementation for the model's core components.

Implementation Index

Campus-level results for the Implementation Index displayed in Figure 3.1 illustrate the wide variation in the levels of technology immersion for the 21 middle schools in the second project year. The Implementation Index, which measures the overall presence of the seven components of immersion, is a *z* score with a mean of 0 and a standard deviation of 1.0. Thus, the score for each campus indicates how many standard deviations from the mean a score lies. Campuses with scores above 0 have higher values on the components of technology immersion, whereas campuses with index values below zero show less evidence of the immersion components. Results suggest that about a third of middle schools (6), with Implementation Index scores ranging from 0.97 to 1.91 standard deviations above the mean, have a much stronger presence of the components of technology immersion compared to other schools, thus a higher level of implementation that more nearly approximates expected standards.

[3] 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.

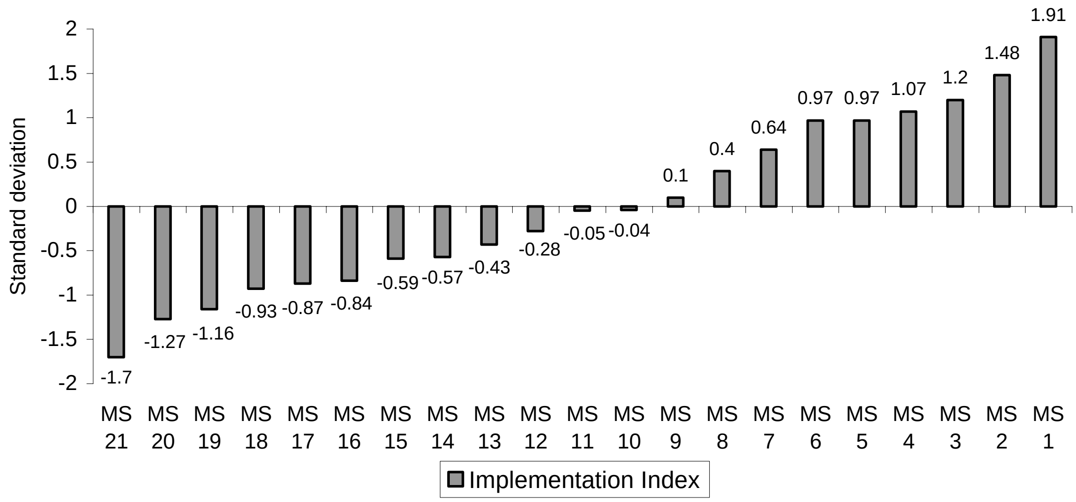

Figure 3.1. Campus means for 21 immersion middle schools (MS) on the Technology Immersion Implementation Index (standardized scores [*z* scores] with a mean of 0 and a standard deviation of 1.0).

Although the Implementation Index is helpful in comparing the relative level of implementation across campuses, it is also important to examine the degree to which middle schools are attaining the standards that represent what a substantially or fully immersed campus should achieve. As another way to gauge successful implementation, we used standards-based scores that describe the extent to which treatment schools received various supports for implementation and the degree to which schools implemented the instructional and learning components of immersion as designed.

Implementation Standards

As explained previously, progress toward technology immersion standards is 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 assess the strength of supports for technology immersion (Leadership, Teacher Support, Parent/Community Support, Technical Support, Professional Development), whereas two components gauge the extent of technology immersion (Classroom Immersion and Student Access and Use). Figure 3.2 displays the mean implementation scores by component. Mean immersion standard scores ranging from 2.48 to 3.06 showed that supports for technology immersion from school principals, teachers, the community, technical staff, and professional development providers did not meet full implementation standards (mean score of 3.50 to 4.00). With insufficient levels of support, classroom- and student-related components of immersion were implemented to a modest extent. Teachers, on average, reported only *partial* levels of Classroom Immersion (M = 2.48) and students, as a whole, reported *partial* (but even lower) levels of technology access and use (M = 2.17). Results for individual components are discussed in detail below.

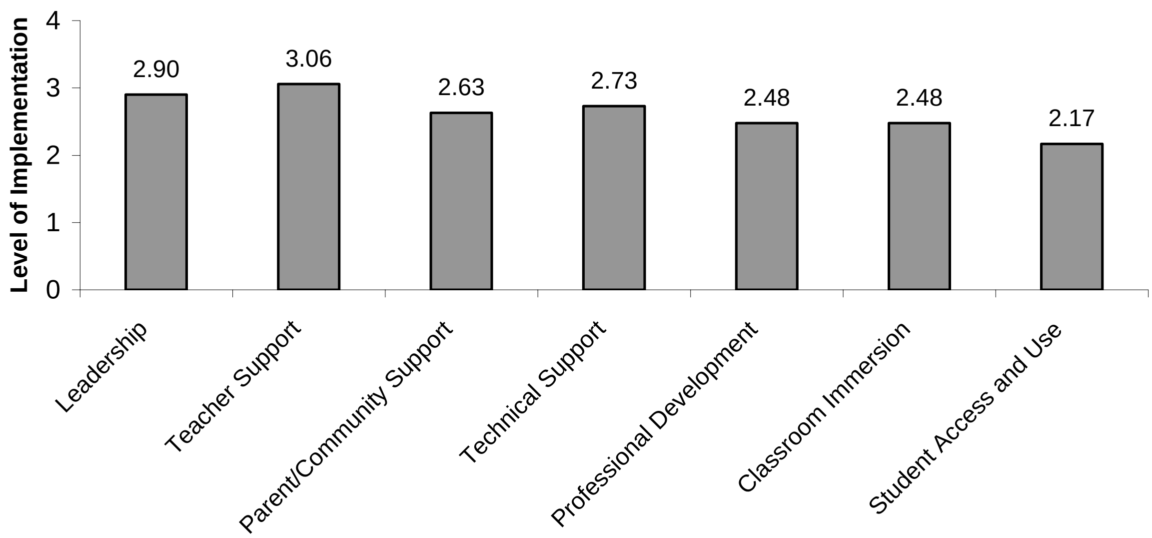

Figure 3.2. Mean level of implementation (measured on a 0 to 4 scale) for seven Technology Immersion components (N=21 middle schools).[4]

Level of Principal, Teacher, and Parent/Community Support

The technology immersion model calls for the systemic integration of technology across key areas of the school, including teaching and learning, educator development, administration and support services, and infrastructure for technology. Momentum for implementation, thus, depends upon the backing and support of individuals, establishment of institutional norms, and assistance from the surrounding community. Figure 3.3 shows teachers' reported support for implementation from key constituents.

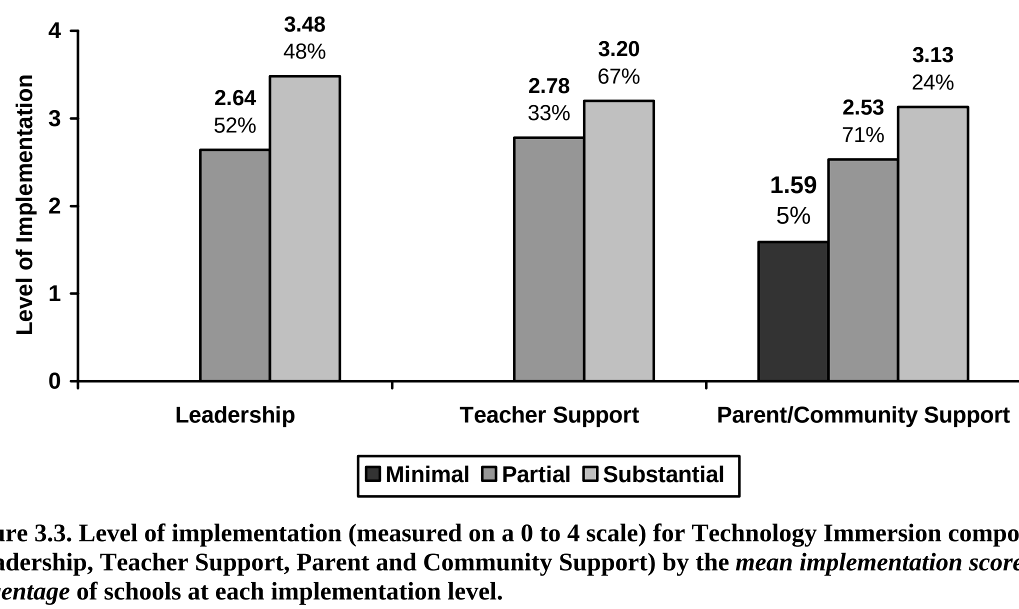

Figure 3.3. Level of implementation (measured on a 0 to 4 scale) for Technology Immersion components (Leadership, Teacher Support, Parent and Community Support) by the *mean implementation score* and *percentage* of schools at each implementation level.

[4] 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.

Leadership. Principals play a key role not only in the decision to become an immersion campus but also as the champion for school innovation and change, manager of reform efforts, and provider of needed resources. Accordingly, teachers at each school were asked to rate the extent to which their principals provided leadership for immersion. Principals 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 3.3 show that teachers in about half of schools reported only partial levels of principal support for technology immersion (M = 2.64). An additional half of campuses reported substantial levels of support (M = 3.48, indicating that they either *agreed* or *strongly agreed* that their principals provided technology-related leadership). In none of the schools did responding teachers *strongly agree* that principals provided the kind of leadership necessary for full immersion.

Teacher Support. Ample evidence demonstrates that teachers are central to the implementation of any initiative aimed at fundamental school change. Specifically, teachers' commitment to the reform is affected by their beliefs about the need for school reform and changes in classroom practice (Desimone, 2002; Fullan & Hargreaves, 1996; Hargreaves, 1994). Teacher buy-in is critically important for technology immersion because teachers are to a large extent the mediators of students' technology experiences. Thus, it is noteworthy that these teachers reported modest support for technology. Teachers at a third of campuses reported partial levels of support (M = 2.78). That is, teachers at these schools were *unsure* 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. Although teachers at two-thirds of schools reported substantial support for innovative practices, their mean score (3.20) showed moderate rather than strong buy-in.

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 a key part of implementation. Additionally, the enthusiastic support of community members, including elected members of the local school board and business people, may influence the level of implementation through mechanisms such as the adoption of supportive policies, provision of resources, or promotion of positive public relations. More important, a lack of parent and community support has been associated with the failure of other school reforms (Desimone, 2002). Unfortunately, at most of the 21 middle schools, the level of parent and community support was less than expected. Teachers at three-fourths of campuses reported minimal (M = 1.59) or partial (M = 2.53) levels of parent and community support. On the other hand, teachers at a quarter of campuses reported substantial support (M = 3.13), with teachers generally agreeing that parents and the surrounding community supported their efforts with technology.

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 is expected to be provided by the vendors who furnish technology immersion packages as well as district- and campus-level staff who assist with implementation and offer timely support when technical problems arise. As with the other support mechanisms described above, the level of technical support for immersion typically failed to meet expectations (see Figure 3.4). Teachers at about four-fifths of campuses reported a partial level of technical support for implementation (M = 2.62). These teachers were generally *unsure* that school computers are kept in working order, requests for assistance are addressed in a timely way, Internet connections work adequately, and classroom materials are readily available. Teachers at a few campuses reported a substantial level of technical support (*M* = 3.12), and teachers at one campus reported a full level of support (*M* = 3.50). Findings as a whole suggested that inadequate levels of technical support for technology immersion challenged most middle school teachers.

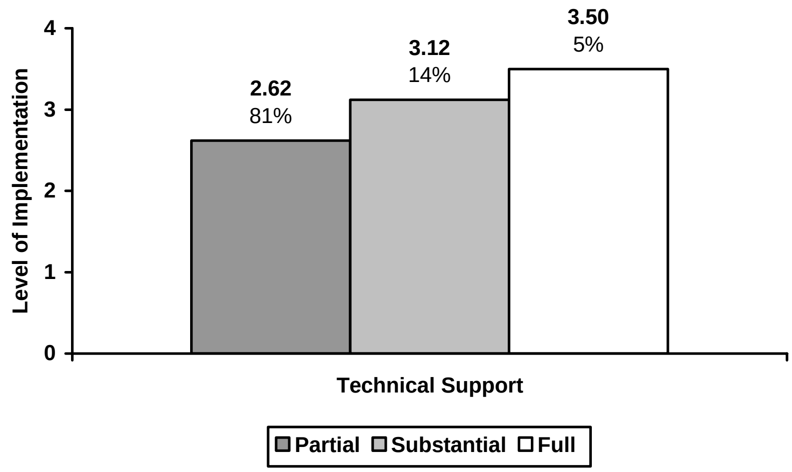

Figure 3.4. Level of implementation (measured on a 0 to 4 scale) for Technical Support component by *mean implementation score* and *percentage* of schools at each implementation level.

Professional Development. Each of the technology immersion packages was required to include a professional development component designed to support technology immersion for all educators on an implementing campus. The technology immersion model calls for professional development that instructs educators in effective classroom integration and is delivered through proven methods (i.e., learning through a variety of delivery systems, collaboration, sustained learning opportunities, and ongoing coaching and support). Findings for elements of professional development displayed in Figure 3.5 show that schools' staffs typically were not exposed to either the prescribed amount or type of professional development.

Although professional development providers were obligated to support all teachers, we concentrated on core-subject teachers because of their close association with measurable student outcomes. First, core teachers at the majority of campuses reported receiving less than the prescribed number of hours of technology-related professional development over the first two implementation years (estimated by project staff and vendors to be about 80 hours). Teachers in about half of schools reported a minimal level of professional development (*M* = 1.28, 35 or less hours, on average). In contrast, teachers in more than a third of schools received nearly the requisite number of hours (substantial to full implementation levels). Additionally, core teachers typically reported that they received only a minimal (*M* = 1.76) or partial (*M* = 2.30) level of classroom support for technology immersion. This meant 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).

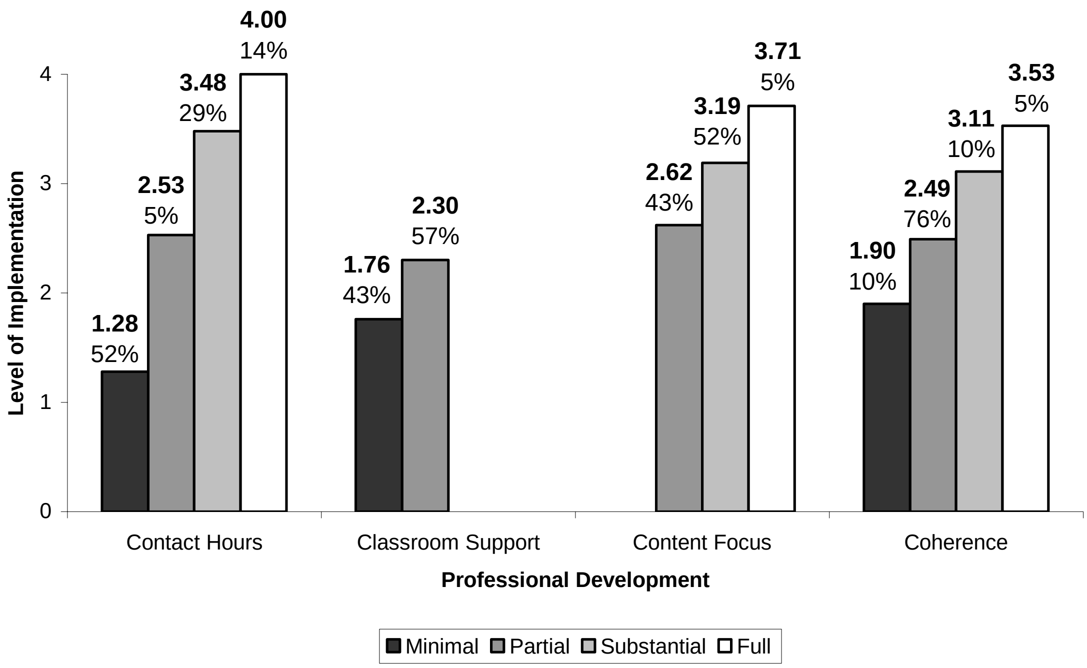

Figure 3.5. Level of Implementation (measured on a 0 to 4 scale) for elements of the Professional Development component (Contact Hours, Classroom Support, Content Focus, and Coherence) by *mean implementation score* and *percentage* of schools at each level.

Core teachers who participated in technology-related professional development expressed varying views on the extent to which activities supported the curricular and instructional goals of the technology immersion model. Teachers at nearly half of schools reported that the content of professional development placed a *minor* emphasis on curriculum, instructional methods, and lesson development in core areas (*M* = 2.62, partial implementation). On the other hand, teachers at more than half of schools indicated there was at least a *moderate* to *major* emphasis on the prescribed content.

Teachers also typically failed to see the coherence of technology-related professional development with their personal goals, earlier learning experiences, and state/district curriculum standards and assessments. Teachers at almost all campus reported that professional development was either *not at all* coherent (*M* = 1.90, minimal implementation) or coherent *to a minimal extent* (*M* = 2.49, partial implementation). Teachers at only a few campuses reported that professional development was coherent to a *moderate extent* (*M* = 3.11, substantial implementation) or *great extent* (*M* = 3.53, full implementation). In general, it appeared that many core-content teachers did not receive the kind of professional development intended to advance technology immersion, and the nature of professional development received varied widely across schools.

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. Ideally, a technology immersed classroom provides a means for more engaged, relevant, meaningful, and personalized student learning. Figure 3.6 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. Overall, teachers reported only minimal to partial levels of implementation for the elements of classroom immersion.

Technology Integration and Learner-Centered Instruction. Just as teachers as a whole must buy-in to the concept of technology immersion, individual core-subject area teachers must believe that new technologies are relevant to their particular curriculum and instructional practices and that new methods have the potential to positively influence student outcomes. Researchers have found that when the pedagogical design of reform models is more compatible with teachers' own ideology, they embrace change more strongly (Datnow & Castellano, 2000). For the technology immersion model, teachers reported the strength of their affiliation with technology integration and learner-centered instruction. Notably, teachers at nearly all of campuses reported only minimal (*M* = 1.86) or partial (*M* = 2.53) levels of affinity for technology integration. Teachers at these schools reported it was either *not true* or just *somewhat true* that they now modify their instructional practices in significant ways through technology. In contrast, teachers at only two schools indicated that it is *somewhat* to *very true now* that they alter their instructional practices, allocate time, integrate current research on teaching and learning, improve basic skills, and support higher-order thinking through technology. (*M* = 3.06, substantial immersion).

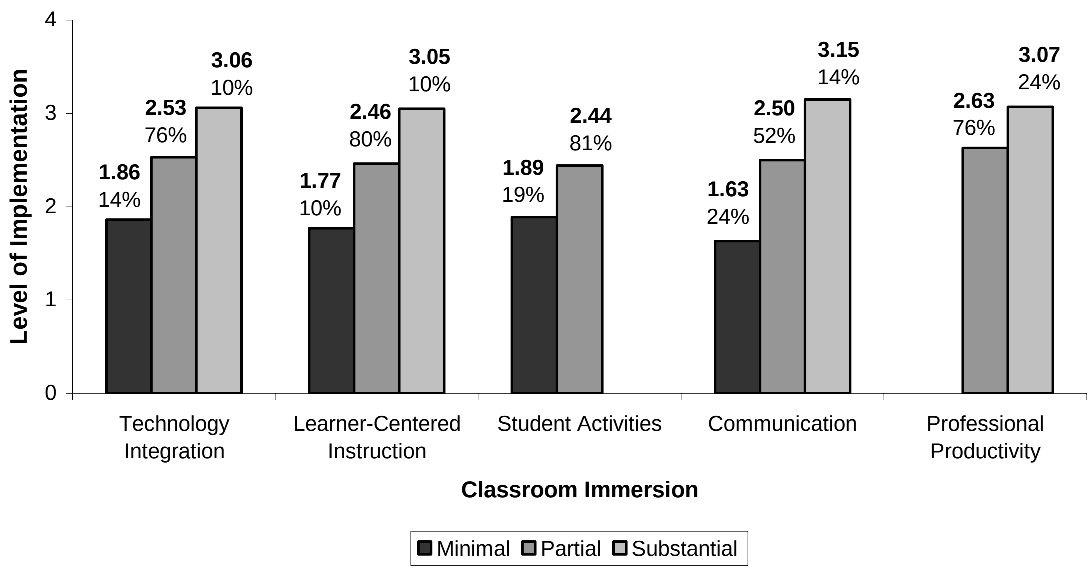

Figure 3.6 Level of Implementation (measured on a 0 to 4 scale) for five elements of the Classroom Immersion component (Technology Integration, Learner-Centered Instruction, Student Activities, Communication, and Professional Productivity) by the *mean implementation score* and *percentage* of schools at each implementation level.

Teachers' responses relative to learner-centered instruction mirror their beliefs about technology integration. Teachers at almost all schools reported minimal (*M* = 1.77) or partial (*M* = 2.46) levels of implementation relative to the adoption of learner-centered practices. Core teachers at these campuses indicated that it was either *not true* or just *somewhat true* that their students establish learning goals, use information and inquiry skills, complete alternative assessments, and have active and relevant learning experiences. Teachers at just a tenth of campuses reported a substantial level of implementation (*M* = 3.05), saying that it was *somewhat* to *very true* that they now use learner-centered methods. Overall results indicated that core-subject teachers at many schools are not strongly committed to the instructional and learning practices advocated as part of technology immersion, and in fact, these methods may be incompatible with many teachers' ideological beliefs and values.

Student Classroom Activities. Teachers in immersed classrooms also are expected to have their students use technology resources to support core-content learning on an almost daily basis. At about a fifth of schools, however, teachers of core subjects (English/language arts, mathematics, science, and social studies) reported that their students *rarely* (a few times a year) or *never* use technology resources (*M* = 1.89, minimal implementation). For example, students seldom use a word processor to write a story, use software to learn and practice skills, create a presentation, or conduct Internet research. At another four-fifths of schools, teachers reported that their students *sometimes* (once or twice a month) use various technology resources to support core-content learning (*M* = 2.44, partial implementation). On average, teachers at none of the campuses reported substantial to full implementation, with students using technology resources *often* (once or twice a week) to *almost daily*. Findings indicated that teachers, in general, are not using fully the instructional and learning resources provided as part of the technology immersion packages.

Communication and Professional Productivity. Wireless computing devices and supporting software provided through technology immersion packages allow educators and students to use technology on a daily basis as a tool for learning, communication, and productivity. *Appleworks* provided a suite of communication tools at the Apple campuses, whereas at Dell campuses, *Microsoft Office* and *eChalk* provided software and a web-based portal for resources and email. Despite the availability of communication tools, teachers at a quarter of campuses reported a minimal level of implementation for communication (*M* = 1.63). Teachers at these campuses *rarely* (a few times a year) or *never* used technology to communicate with students, parents, or their colleagues, or to post information for students on a class website. Teachers at an additional half of schools reported that they just *sometimes* (once or twice a month) used technology for communication (*M* = 2.50, partial immersion). On the other hand, teachers at a few campuses reported a substantial level of implementation (*M* = 3.15), with email and web-based communication tools used *often* (once or twice a week).

In contrast to other elements of classroom immersion, teachers more often reported the use of technology to enhance their professional productivity. Teachers at three-quarters of campuses indicated that they *sometimes* used technology for activities such as keeping records, analyzing data, developing lessons, and delivering information using presentations. Teachers at an additional quarter of campuses reported a substantial level of implementation, with technology used *often* (once or twice a week) for professional productivity purposes. Overall findings on teachers' reported levels of classroom immersion are generally consistent with other research on teachers' adoption of technology-based practices. In the early stages of implementation, teachers discover the potential of technology use for increased productivity and begin to use it as an instructional tool on a limited basis (Sandholtz, Ringstaff, & Dwyer, 1997).

Level of Student Technology Access and Use

Although the transformation of teaching and learning in the classroom is a critical part of technology immersion, the model also aims to provide on-demand technology access for students, which allows them to become more independent and self-determined learners both within and outside of the school. 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). Student access to their laptops, however, may be affected by a number of factors, such as disciplinary infractions, technical issues, time for repairs, and parent resistance. Overall data reported by students indicates that the number of days that students actually had laptops available for use out of the 180-day school year varied widely both across and within schools (see Figure 3.7). At about a sixth of campuses, students had a minimal level of access (*M* = 1.40), indicating that laptop access days varied to an *extremely large extent* (from 42 to 169 days per student). Students at about half of campuses had only a partial level of access (*M* = 2.57), with student access days varying to a *large extent* (from 100 to 176 days per student). At about a third of campuses, students reported a substantial level of access (*M* = 3.15), signifying that student access varied from about 140 to 178 days per student. Conversely, students at about a tenth of campuses had a full level of access, with laptops available the targeted 170 to 180 days per student.

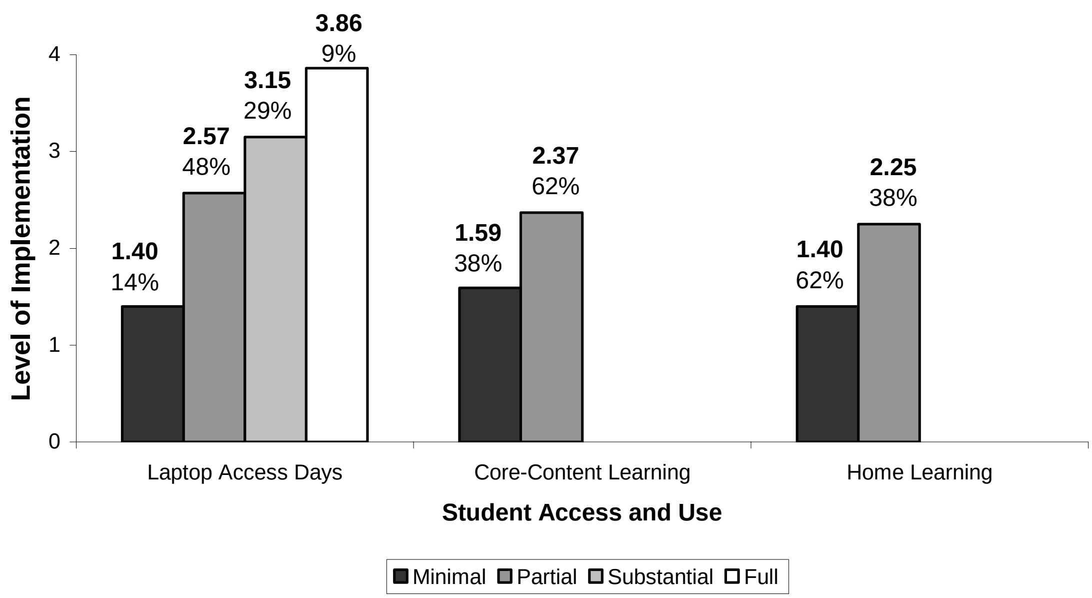

Figure 3.7. Level of Implementation (measured on a 0 to 4 scale) for elements of the Student Access and Use component (Laptop Access Days, Core-Content Learning, and Home Learning) by *mean implementation score* and *percentage* of schools at each implementation level.

Students also estimated how often they used their laptops in their English/language arts, mathematics, science, and social studies classes. Similar to teachers, students at more than one-third of campuses reported a minimal level of implementation (*M* = 1.59), indicating that they *rarely* (a few times a year) or *never* used technology-resources in core-subject classes. Students at the remaining two-thirds of schools reported a partial level of implementation (*M* = 2.37), with laptops used *sometimes* (once or twice a month) to *often* (once or twice a week) in core classrooms. While students as a whole used their laptops infrequently for learning in core classrooms, they use them even less often for learning outside of school. Students in almost two-thirds of schools reported a minimal level of laptop use for home learning (*M* = 1.40). These students used their laptops outside of school for homework and learning either *not at all* or *to a trivial extent*. Students in the remaining third of schools used their laptops for home learning at a minimal level (*M* = 2.25). Students at none of the schools used their laptops outside of school to either a substantial or full level of immersion (i.e., used laptops to a *moderate* or *large* extent, respectively).

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. As noted earlier, in some schools, students' laptop access days were drastically reduced by factors such as disciplinary actions and time for repairs. 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).

In sum, overall results for the implementation of technology immersion suggest that in the second year, the level of implementation varied widely by campus and none of the middle schools achieved *full immersion*. Results for the campus Implementation Index combined with evidence from standards-based scores suggest that about a third of campuses (6) reached *substantial immersion*, whereas the majority of campuses (15) achieved only *minimal* to *partial immersion* in the second year.

Implementation Indices by Component of Technology Immersion

To further illustrate each school's level of immersion, Table 3.3 presents the composite campus Implementation Index (*z* score) alongside implementation indices (*z* scores) for each of the seven components. Despite some variations in component scores, middle schools that had higher values on the Implementation Index tended to have component scores that indicated a stronger presence of the immersion attributes such as principal leadership and teacher support for immersion. In contrast, middle schools that had extremely 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 noteworthy exceptions to the prevailing trends. Some schools, such as MS 21, had generally lower implementation values for most of the indicators except Classroom Immersion (0.84). This suggests that teachers at that school are making strides toward classroom integration of technology even though strong supports are not in place. In contrast, despite strong values for support indicators, teachers in MS 1 have a relatively low presence of classroom immersion attributes. The relationships among implementation variables are explored further in the section to follow.

Table 3.3. Second-Year Implementation of Technology Immersion

Middle School (MS)	Leader-ship Index	Teacher Support Index	Parent/ Comm. Index	Technical Support Index	PD Index	Classroom Immersion Index	Student Access/Use Index	**Implemen-tation Index**
MS 1	1.78	1.18	1.05	1.28	2.09	0.58	1.78	**1.91**
MS 2	0.97	1.15	1.60	1.45	0.86	0.58	0.91	**1.48**
MS 3	0.65	1.25	0.50	-0.39	1.52	1.49	1.12	**1.20**
MS 4	0.79	1.24	1.45	0.32	0.78	0.28	0.62	**1.07**
MS 5	1.13	0.29	0.61	2.67	-0.04	0.07	0.21	**0.97**
MS 6	1.12	0.78	1.07	0.73	0.53	0.32	0.38	**0.97**
MS 7	0.36	0.42	0.95	-0.54	0.26	1.68	0.10	**0.64**
MS 8	0.43	0.44	0.50	-0.74	1.91	-1.03	0.53	**0.40**
MS 9	0.58	0.20	0.03	-0.80	0.03	1.06	-0.59	**0.10**
MS 10	-0.60	-0.16	0.12	-0.31	-0.18	0.95	-0.05	**-0.04**
MS 11	0.16	0.22	-0.14	0.24	-0.98	0.72	-0.48	**-0.05**
MS 12	-0.89	-0.35	-0.72	-0.75	-0.16	0.53	0.90	**-0.28**
MS 13	-0.62	0.33	-0.79	1.37	-1.44	-1.74	0.70	**-0.43**
MS 14	-0.69	-0.28	-0.55	0.08	-0.83	-0.86	0.23	**-0.57**
MS 15	-0.46	-0.33	0.05	-0.45	-1.13	-1.31	0.63	**-0.59**
MS 16	0.92	0.11	-0.14	-1.11	-0.23	-1.27	-2.55	**-0.84**
MS 17	-0.19	-0.72	-0.04	-1.42	-0.53	-0.39	-1.16	**-0.87**
MS 18	-0.77	-0.12	-1.16	-0.36	-0.07	-0.57	-1.68	**-0.93**
MS 19	-1.03	-1.99	-0.73	-0.45	-0.19	-1.07	-0.46	**-1.16**
MS 20	-1.42	-1.03	-1.10	-0.15	-1.30	-0.85	-0.63	**-1.27**
MS 21	-2.20	-2.65	-2.59	-0.68	-0.92	0.84	-0.50	**-1.70**

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.

Factors Associated with Implementation

In this section, we explore relationships among various implementation components of technology immersion and examine whether particular support mechanisms or school characteristics are associated with teachers' self-reported levels of classroom immersion and students' estimations of their technology access and use. The strength of relationships between implementation levels for immersion components (mean campus *z* scores) and school characteristics (mean enrollment counts, percentages of minority and economically disadvantaged students, and percentages of students passing TAKS tests) are examined individually through bivariate correlations.

Immersion Components

Table 3.4 displays the correlations between the seven components of technology immersion, with statistically significant coefficients denoted in bold. As anticipated, teachers' perceptions of their principal's leadership for immersion was strongly associated with their collective support for technology innovation, as well as their views on parent and community support, the presence of technical support, and the robustness of professional development. And reasonably, teachers' commitment to technology innovation was significantly related to other support mechanisms in addition to the level of students' technology access and use. On the contrary, teachers' support for technology innovation showed almost no association with the strength of their classroom immersion.

Table 3.4. Correlations of Technology Immersion Components

	Components of Technology Immersion						
Components	Leader-ship	Teacher Support	Parent Support	Technical Support	PD	Class Immersion	Student Access/Use
Leadership							
Teacher Support	**.85*****						
Parent/Community Support	**.88*****	**.84*****					
Technical Support	**.42†**	**.42†**	**.38†**				
Professional Development	**.69****	**.61****	**.65****	.13			
Classroom Immersion	.26	.02	.30	.02	**.38†**		
Student Access and Use	.29	**.45***	**.46***	**.49***	**.45***	.28	

Note. †$p < .10$, *$p < .05$, **$p < .01$, ***$p < .001$. PD = Professional Development.

Technical support for immersion was most strongly associated with students' reported access to and use of laptops, suggesting that stronger technical support reduced laptop maintenance problems that kept computers out of the hands of students. The intensity of campus professional development supporting immersion was significantly associated with higher levels of implementation for both classroom immersion and student access and use components. Significant correlations also were seen between the strength of professional development and teachers' perceived levels of support from principals, technical leaders, and parent and community members.

The campus level of classroom immersion, unexpectedly, was significantly associated with only one implementation component (professional development). On the other hand, the ultimate goal of technology immersion—students' technology access and use for learning—was significantly related to increased implementation levels for four of five support components. Principals' leadership appeared to affect students indirectly through the facilitation of other supports for immersion.

School Characteristics

We also explored the relationship between implementation components and school characteristics (see Table 3.5). Middle-school campus characteristics included the average student enrollment, percentage of minority students (African American and Hispanic), school poverty (percentage of economically disadvantaged students as measured by eligibility for federal free- and reduced-price lunches), and achievement (percentage of grades 6 to 8 students passing all TAKS tests in spring 2006).

Table 3.5. Correlations of Technology Immersion Components and School Characteristics

	Characteristics of Middle Schools			
Immersion Components	Student Enrollment	Percent Minority Students	Percent Economically Disadvantaged Students	Percent of Students Passing All TAKS Tests
Leadership	-.04	-.23	-.30	.14
Teacher Support	-.03	-.29	**-.42†**	.29
Parent & Community Support	.06	-.19	**-.40†**	.18
Technical Support	**-.46***	-.12	-.22	.32
Professional Development	-.05	-.01	-.20	.13
Classroom Immersion	.14	-.08	-.16	-.22
Student Access & Use	-.24	-.17	**-.41†**	.23
Implementation Index	-.12	-.21	**-.42†**	.21

Note. †$p < .10$, *$p < .05$, **$p < .01$, ***$P < 001$.

Results showed that school size was negatively associated with implementation levels for most technology immersion components. That is, schools with larger student enrollments tended to have slightly lower levels of implementation than schools with fewer students, although the negative relationship was significant for only one component. Teachers at larger schools reported significantly lower levels of technical support, which indicated that technical problems at these schools posed a greater barrier to technology immersion.

Higher percentages of minority students (African American and Hispanic) also showed a weakly negative relationship with implementation components, whereas higher percentages of economically disadvantaged students at a school surfaced as having an overall negative and sometimes significantly negative relationship with implementation levels. Schools with more disadvantaged populations had significantly lower levels of implementation for teacher support, parent and community support, student technology access and use, and for the composite Implementation Index.

In contrast to the negative relationships between school demographic characteristics and levels of implementation, the school's achievement context was positively associated with nearly all of the implementation indicators, although correlations were generally low. Teachers' reported level of classroom immersion was the only immersion component that was negatively correlated with achievement.

Classroom Immersion

To further understand teachers' perspectives, an additional analysis examined the relationships among support components, school characteristics, and elements of core-subject teachers' classroom immersion. Correlation coefficients presented in Table 3.6 showed generally low associations among variables, with some positive and some negative relationships. Still, a few statistically significant findings surfaced. Classroom immersion elements that assessed the strength of teachers' ideological agreement with technology innovation and constructivist practices (technology integration and learner-centered instruction) were significantly related to teachers' perceptions of the viability of various support components, including principal leadership, parent and community support, and professional development. Teachers' perceptions of the robustness of professional development also showed the strongest relationship with the composite Classroom Immersion Index.

Table 3.6. Correlations of Support Components and School Characteristics by Elements of Classroom Immersion

	Core-Subject Teachers' Classroom Immersion					
Indicators/Characteristics	Technology Integration	Learner-Centered Instruction	Student Activities	Communi-cation	Professional Productivity	**Classroom Immersion Index**
Leadership	**.44***	**.40***	.09	.10	.02	.26
Teacher Support	.35	.33	.02	.23	.04	.26
Parent & Community Support	**.46***	**.40†**	.09	.22	-.01	.30
Technical Support	.09	-.01	-.02	.11	-.25	.02
Professional Development	**.38†**	**.51***	.23	.16	.27	**.38†**
School enrollment	.05	.08	.09	.17	.25	.14
% minority students	-.20	-.10	.12	-.22	.23	-.08
% Disadvantaged students	-.17	-.07	.19	**-.43†**	.11	-.16
% Students pass all TAKS	-.24	-.28	**-.47***	.19	-.39	-.22

Note. †$p < .10$, *$p < .05$, **$p < .01$, *** $P < .001$.

On the other hand, a school's mean achievement on TAKS was negatively associated with teachers' reported implementation levels for five of six classroom immersion elements. Notably, the association between campus TAKS scores and teachers' reported frequency of their students' classroom technology activities was negative and statistically significant. This suggests that simply increasing the frequency of classroom technology use may not produce desirable student outcomes. The only positive association between classroom immersion indicators and student achievement was the frequency of teachers' technology use for communication via email or a class website. Teachers at campuses with higher achieving students used technology more often for communication, whereas teachers at campuses with larger minority and disadvantaged student populations communicated with technology less often.

Student Access and Use

Correlations for students' reported levels of technology access and use also showed important trends (Table 3.7). First, the strength of the composite Student Access and Use Index was significantly related to stronger levels of implementation for various support mechanisms (teacher, parent/community, and technical support, and teacher professional development). The Student Access and Use Index, however, was negatively associated with larger school size and higher percentages of minority and economically disadvantaged students.

Table 3.7. Correlations for Support Components and School Characteristics by Elements of Student Access and Use

	Student Technology Access and Use			
Indicators/Characteristics	Laptop Access Days	Classroom Learning	Home Learning	**Student Access/Use Index**
Leadership	-.06	.18	.32	.29
Teacher Support	.09	.20	**.50***	**.45***
Parent & Community Support	.12	.22	**.47***	**.45***
Technical Support	**.45***	**.46***	.18	**.49***
Professional Development	.04	.28	**.46***	**.45***
School Enrollment	-.29	**-.59****	.31	-.24
% Minority Students	-.10	-.29	.05	-.17
% Disadvantaged students	-.15	-.31	-.30	**-.41†**
% Students pass all TAKS	.05	.20	.17	.23

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

Second, as might be expected, the strength of campus technical support was significantly related to the number of days that students had their laptops available for use and the frequency with which they used their laptops in core-subject classrooms for learning. Results also suggested that certain types of support enabled students to use their laptops more productively at home. Significant correlations showed that the level of teacher and parent/community support for immersion, and the campus emphasis on professional development were positively associated with the extent to which students' reported using their laptops for learning at home (i.e., homework and learning games). Finally, findings showed that the robustness of a student's technology access and use was associated with the characteristics of the school that he or she attended. Students attending larger schools and schools with larger minority and economically disadvantaged populations reported generally lower levels of technology access and use. Given the variations in student experiences across immersion campuses, it was noteworthy that students' reported technology access and use was positively, though weakly, associated with campus academic achievement.

Conclusions

This chapter described technology immersion components, as defined by the Texas Education Agency and further operationalized through technology immersion packages. In the second year, 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 are derived from values for components relative to supports for immersion, and the extent of classroom immersion and students' technology access and use. Major findings are the following:

- The majority of middle schools struggled in the second year to implement the prescribed components of technology immersion. The Implementation Index, a composite score measuring the overall presence of immersion components, showed that about a third of middle schools had a much stronger level of immersion than the other schools (i.e., *substantial immersion*). No middle schools reached *full immersion* in the second year.
- Many schools needed stronger supports in the areas of school leadership, teachers' commitment to innovative technology practices, parents' support for students' technology use, and technical supports that addressed obstacles to technology use.[5]
- Core-subject teachers, as a whole, are using new technology resources to enhance their own professional productivity and to support existing instructional practices. Teachers at many schools, however, use technology resources sporadically in their classrooms. While some teachers are making noteworthy progress toward classroom immersion, other teachers believe new technologies are less relevant to their curriculum and instructional practices and, in some instances, inconsistent with their ideological beliefs and values.
- Students' access to and use of laptops for learning within and outside of school fell short of expectations. Some schools allowed students to have unlimited home access, while others restricted out-of-school laptop use. Restrictions diminished the possibilities for student learning with laptops at home. Likewise, teachers' varying commitment to classroom immersion affected students' opportunities to learn with technology in core-content classes. Overall, students' experiences with laptops varied substantially across classrooms and schools.

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[5]While there were substantial differences in available supports among immersion schools, immersion teachers as a whole perceived significantly stronger school-level supports for technology than control teachers. See comparisons between immersion and control teachers in Appendix D.

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 implementation levels.

4. Effects of Technology Immersion on Teachers and Teaching

In the theoretical model, researchers hypothesize that given quality implementation of technology immersion (i.e., supportive school leaders, robust student technology access, effective use of online curricular and assessment resources, professional development supporting curricular integration, and adequate technical and pedagogical support to maintain an immersed campus), one might expect school-level improvements in teachers' commitment to technology innovation, technical support for implementation, and parent and community support. Effective principal leaders are believed to provide the kinds of supports that fortify implementation. A more supportive school environment should lead in turn 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 a higher level of school and classroom immersion will use laptops as a tool to increase the intellectual challenge of lessons and will have students who use technology more in their classrooms.

Contrary to expectations regarding the implementation of technology immersion, results reported in Chapter 3 revealed wide variation from school-to-school in the levels of implementation. None of the 21 middle schools had reached *full immersion* in the second project year, and in fact, results showed that just about a third of middle schools approached a *substantial* level of immersion. More important, two-thirds of schools achieved only *minimal* to *partial* implementation. Recognizing that implementation levels at most schools in the second year failed to meet specified standards, we investigated whether or not there is an immersion effect on teachers given that the level of implementation is generally low.

Findings on the effects of technology immersion on teacher-mediating variables that underpin the theoretical model come from online surveys of teachers completed in fall 2004 (September to October) and again in spring of 2005 and 2006 (April to May). Teachers responded to items pertaining to their personal and classroom technology experiences. In fall 2004, 1,271 teachers completed the survey (97% of treatment and 98% of control teachers), and in spring 2005, 1,144 teachers (87% of treatment and 88% of control) responded to the survey. In spring 2006, 1,175 teachers completed the online survey (92% of treatment and 95% of control). Additionally, researchers conducted classroom observations during site visits to each of the treatment and control schools to gather information on instructional practices and changes across time. We conducted observations in a sample of sixth-grade, core-subject classrooms in fall 2004 (64 treatment and 64 control teachers) and again in spring 2005 (117 treatment and 123 control teachers). In spring 2006, researchers conducted observations in both sixth- and seventh-grade classrooms (130 treatment and 113 control teachers).

Teacher Mediating Variables—HLM Analysis

Surveys included measures of seven teacher-level variables. Teachers responded to items gauging their technology knowledge and skills (Technology Proficiency and Professional Productivity); the strength of their ideological views relative to Technology Integration, Learner-Centered Instruction, and Resistance to Integration; the frequency of Student Classroom Activities with technology; and their propensity for Collaboration with peers on technology. Cronbach's alpha reliability coefficients for the teacher-level scale scores ranged from 0.70 to 0.99. (See Appendix B for technical details.)

One 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 three occasions: fall 2004 (baseline), spring 2005 (after the first implementation year) and spring 2006 (after the second implementation year). 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 negative effects of school poverty on school reform efforts (Desimone, 2002) and student achievement (Sirin, 2005). Since TIP grants targeted high-needs schools, the percentages of disadvantaged students are generally high across most of the study's schools. Even so, poverty concentrations vary substantially within comparison groups (ranging from 34.5% to 99.6% for treatment campuses and from 33.7% to 100% for control campuses). 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). 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 33.7% to 100%. 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

Analyses of immersion effects included 802 teachers, with 364 in immersion schools and 438 in control schools. The results presented in Table 4.1 show that after adjusting for school poverty, technology immersion had a statistically significant effect on teachers' rates of growth for six technology-related variables. Teachers at technology immersion schools, on average, had significantly steeper growth trends than teachers at control schools for Technology Proficiency and Professional Productivity, two measures of teachers' ideology (Technology Integration and Learner-Centered Instruction), and the frequency of Student Classroom Activities (with technology) and Collaborative interactions with colleagues on technology-related issues. In contrast, for the Resistance to Integration scale, there was no significant effect of immersion on teachers' mean rate of change.

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

	Immersion Effect Net of School Poverty	Statistics for Teachers in Immersion Schools with Average School Poverty[c]			Yearly Growth Rate for Control Teachers
		Average Estimated Initial Status Fall 2004	Yearly Growth Rate	Average Estimated Score Spring 2006	
Technology Proficiency[a]	Yes	4.33	0.35***	5.03	0.18
Professional Productivity[b]	Yes	2.93	0.26***	3.44	0.09
Ideology					
Technology Integration[a]	Yes	3.07	0.79***	4.66	0.27
Learner-Centered Instruction[a]	Yes	3.60	0.48***	4.55	0.20
Resistance to Integration[a]	No	2.12	-0.01	2.10	0.08
Student Classroom Activities[b]	Yes	1.92	0.33***	2.57	0.04
Collaboration[b]	Yes	2.39	0.21**	2.81	0.06

Source: Online teacher surveys conducted in fall 2004, spring 2005, and spring 2006. *Note.* $*p < .05$; $**p < .01$; $***p < .001$.
[a] Items measured on a 7-point scale. [b] Items measured on a 5-point scale.

Figure 4.1 illustrates the estimated growth trajectories for immersion teachers in schools with average levels of school poverty. Results show that these teachers have positive growth trajectories for all of the technology-related indicators, with the exception of Resistance to Integration, which remains stable across years. There were notable school poverty effects for both immersion and control schools. Teachers working on campuses with higher concentrations of school poverty grew, on average, at a significantly slower rate than their counterparts in more affluent schools on indicators for Technology Proficiency and Technology Integration, and at a somewhat slower rate on indicators for Professional Productivity and Learner-Centered Instruction. Tables 4.2, 4.3, and 4.4 provide school-level statistics for the HLM analyses of immersion effects on teacher technology-related variables. Sections to follow explain results related to changes in teachers' knowledge and skills, ideology, classroom practices, and peer collaboration.

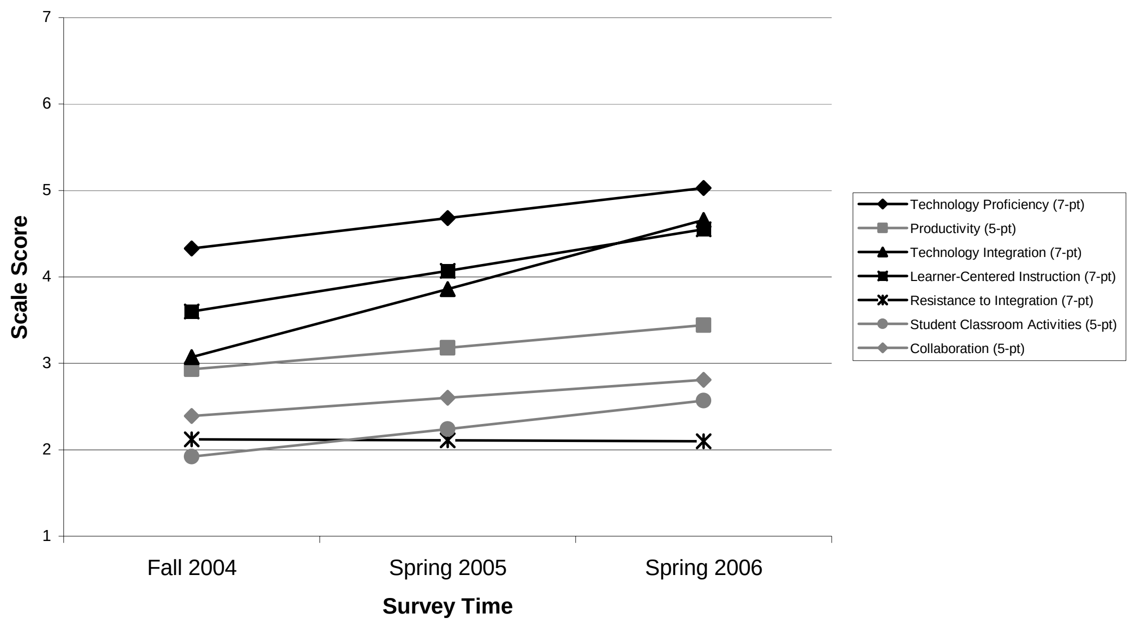

Figure 4.1. Estimated mean growth trajectories for Technology Immersion teachers working in schools with average levels of school poverty on technology-related indicators (ratings on either 5-point or 7-point scales).

Technology Knowledge and Skills

Texas Technology Applications Standards require *all* teachers to master and use technology-related terminology, concepts, and strategies, and to be able to use appropriate tools to accomplish a range of tasks (e.g., communicate with diverse audiences and analyze electronic information). Given the importance the state places on technology knowledge and skills and the potential impact of immersion, 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: 1 and 2 (*not true of me now*); 3, 4, and 5 (*somewhat true of me now*); and 6 and 7 (*very true of me now*). 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). Teachers also reported ratings on items related to classroom instruction, such as using the computer for presentations or creating a lesson plan or unit incorporating technology.

Results in Table 4.2 and Figure 4.2 show that immersion teachers grew in technology proficiency at a significantly faster rate (0.35 scale-score points per year) than control teachers (0.18 points) between fall 2004 and spring 2006. Even though immersion teachers began with slightly lower mean proficiency scores than control teachers in fall, they surpassed control teachers in spring 2005 and continued to grow in proficiency during the next school year.

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

Dependent variable and predictor	Technology Proficiency[a]		Professional Productivity	
	Gamma Coefficient	*t*-value	Gamma Coefficient	*t*-value
Initial status (fall 2004)	4.476	51.88***	2.984	53.30***
Immersion	-0.151	-1.06	-0.057	-0.72
School Poverty	-0.001	-0.15	0.002	0.68
Growth rate	0.176	5.26***	0.089	4.49***
Immersion	0.178	4.02***	0.167	5.90***
School Poverty	-0.004	-2.66*	-0.001	-1.11

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

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 0.004 scale-score decrease in Technology Proficiency. Thus, as Figure 4.2 illustrates, a 20% increase in school poverty predicts a 0.08 point decrease in teachers' yearly growth in proficiency (i.e., 20 x 0.004). As the level of school poverty increases, the teacher proficiency gap continues to widen.

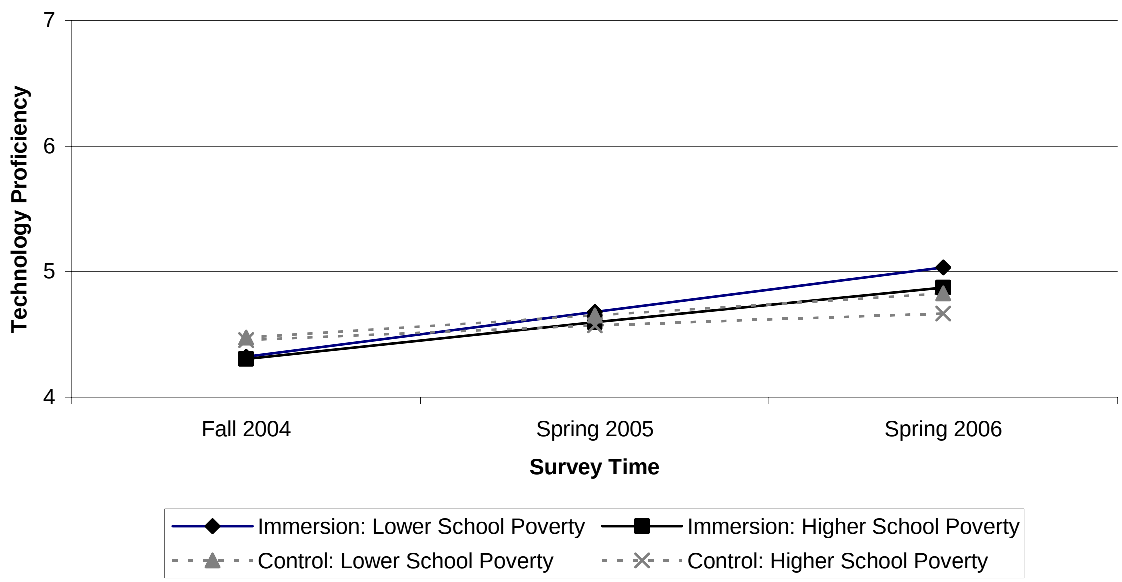

Figure 4.2. Estimated mean growth trajectories for teachers at immersion and control schools for Technology Proficiency (ratings on a 7-point scale). Comparisons are for teachers working in schools with lower concentrations of school poverty, and teachers working in schools with a 20 percentage point higher level of school poverty.

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 more advantaged schools were 0.26 and 0.09 scale-score points per year, respectively. Teachers working in schools with higher percentages of disadvantaged students had slightly slower growth rates.

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*). Confirmatory factor analysis of these items, which were adapted from the Levels of Technology Implementation (LoTi) Questionnaire (Moersch, 2001), showed reasonable fit indices for a model having Technology Integration, Learner-Centered Instruction, and Resistance to Integration as latent variables. Results detailed in Table 4.3 show that teachers at immersion schools, on average, became more positive toward innovative technology practices across time.

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)	2.836	41.80***	3.561	69.45***	2.359	43.59***
Immersion	0.234	2.02*	0.034	0.37	-0.240	-3.20**
School Poverty	0.009	2.83**	0.005	2.30*	0.001	0.76
Growth rate	0.265	6.08***	0.200	5.39***	0.083	2.20*
Immersion	0.528	7.10***	0.278	4.20***	-0.092	-1.66
School Poverty	-0.004	-1.74†	-0.002	-1.18	0.000	-0.08

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

[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, showed that original differences were statistically insignificant (the difference divided by the standard error of the difference = 0.43).

[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, showed that original differences were insignificant (the difference divided by the standard error of the difference = 0.42).

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. Findings show that teachers in immersion and control schools initially expressed similar views about technology integration, but immersion teachers had a significantly more positive rate of change. The mean estimated growth trajectory for immersion teachers who worked in schools having average levels of school poverty was 0.79 scale points per year compared to 0.27 for control teachers. Teachers in schools with higher concentrations of school poverty had significantly slower rates of growth relative to technology integration practices.

Teachers at immersion schools compared to control also changed 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 more advantaged schools was 0.48 and 0.20 scale-score points, respectively.

For the Resistance to Integration scale, teachers expressed their strength of association with items indicating that classroom computers are not a priority, not a necessary part of instruction, and 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 stable across years. The extent of school poverty had a minimal effect on teacher resistance.

Student Classroom Activities and Teacher Collaboration

Table 4.4 provides statistics for scales measuring teachers' classroom activities and collegial collaboration. This 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 their students use technology for writing, learning and practicing skills, communication, or Internet research. As expected, given the availability of laptops at immersion schools, teachers at treatment schools had a significantly faster growth rate for Student Classroom Activities (0.33 and 0.04 scale-score points per year, respectively, for immersion and control teachers in lower poverty schools). School poverty had no discernable effect on teachers' growth rate for the frequency of students' classroom activities involving technology. Despite immersion teachers' positive growth trends for the frequency of their students' use of technology in the classroom, estimated mean scores indicated that by spring 2006, immersion teachers, on average, had students use various technology applications in their class infrequently (about once or twice a month, $M = 2.57$).

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

	Student Classroom Activities		Teacher Collaboration[a]	
Dependent variable and predictor	Gamma Coefficient	*t*-value	Gamma Coefficient	*t*-value
Initial status (fall 2004)	1.864	41.03***	2.255	42.24***
Immersion	0.052	0.80	0.138	1.73[†]
School Poverty	0.004	2.07*	0.003	1.28
Growth rate	0.043	2.01*	0.055	2.47*
Immersion	0.285	8.03***	0.154	3.72**
School Poverty	0.000	0.13	0.001	1.14

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

[a] Technology immersion teachers had significantly higher initial Collaboration scores. A latent variable regression, controlling for the effect of this initial difference on the growth rate, showed that original differences were statistically insignificant (the difference divided by the standard error of the difference = 1.54 for Collaboration).

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 coaching and mentoring, collectively developing technology lessons, and exchanging information about their students. As expected, immersion teachers had a steeper mean yearly growth trend for Collaboration (0.21 scale-score points) than control teachers (0.06 points). However, the growth rate coefficients for both teacher groups were significant, indicating that teachers across comparison groups were increasingly interacting with peers on technology practices. This may reflect the fact that both treatment and control campuses received Title II, Part D grants, with 25% of dollars allocated for technology-related professional development. Campus poverty had a negligible effect on teacher collaboration.

Effects of Immersion on Classroom Practice

Researchers conducted classroom observations in a sample of sixth-grade core-subject classrooms in fall 2004 and spring 2005 (reading/English language arts, mathematics, science, and social studies teachers of Cohort 1 students). In spring 2006, we modified the classroom sample to include observations for seventh-grade teachers of Cohort 1 students and sixth-grade teachers of Cohort 2 students. Classroom observations were conducted by single observers (about 75% of classrooms) and pairs of observers (about 25% of classrooms). Paired observations permitted the calculation of inter-observer agreement. In fall 2004, researchers observed 128 classrooms (64 treatment and 64 control) in 22 schools. In spring 2005 and 2006, we expanded observations to include all schools. We observed 240 classrooms in 2005 (117 treatment and 123 control), and 243 classrooms in 2006 (130 treatment and 113 control). At small campuses, researchers observed nearly all core-content teachers; at large campuses, we observed at least eight classrooms (about half of core teachers).

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

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

- *Construction of Knowledge: Higher Order Thinking*. Instruction involves students in manipulating information about ideas by synthesizing, generalizing, explaining, hypothesizing, or arriving at conclusions that produce new meaning and understanding for them.
- *Disciplined Inquiry: Deep Knowledge.* Instruction addresses central ideas of a topic or discipline with enough thoroughness to explore connections and relationships and to produce relatively complex understandings.
- *Disciplined Inquiry: Substantive Conversation*. Students engage in extended conversational exchanges with the teacher or peers about subject matter in a way that builds an improved and shared understanding of ideas or topics.
- *Value Beyond School: Connections to the World Beyond the Classroom.* (Newmann, Secada, & Wehlage, 1995).

An aggregate score across three of the four scales was used as an overall measure of the Intellectual Challenge of instruction for each teacher. We omitted the rating for Substantive Conversation because ratings were highly influenced by the organizational structure of lessons. Specifically, lessons involving teacher guided whole-group or small-group discussions yielded better opportunities to gather evidence on conversation than lessons with students working individually. Additionally, to enhance observer agreement for Intellectual Challenge ratings, we conducted training sessions for researchers immediately before each series of site visits began. We also utilized Many-Facets Rasch Analysis (Linacre, 2004) to adjust the measure of Intellectual Challenge for the relative severity (or leniency) of each observer during analyses.

Table 4.5 reports the adjusted composite Intellectual Challenge scores for immersion and control teachers in fall 2004 and spring of 2005 and 2006. In fall, the sixth-grade control teachers' mean score (1.86) was significantly higher than the immersion teachers' mean score (1.55). The difference favoring the control teachers represented a moderate effect size (-0.41). Thus, the sample of control teachers in fall engaged students in lessons involving a higher level of intellectual challenge. That is, lessons required a higher level of thinking, delved into topics more thoroughly, and made stronger connections with students' background experiences and the world beyond the classroom. On the contrary, in spring 2005, sixth-grade teachers at immersion schools had a slightly higher mean score (1.84) than control teachers (1.78), but the difference between the groups was statistically insignificant.

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

	Immersion			Control					Effect
Group	*N*	Mean	*SD*	*N*	Mean	*SD*	*t*-value	*p*	Size
Fall 2004[a]	69	1.55	0.67	73	1.86	0.89	-2.45	0.020*	-0.41
Spring 2005[a]	110	1.84	0.92	119	1.78	0.87	0.47	0.640	0.06
Spring 2006[a]	63	1.72	0.61	58	1.75	0.72	-0.24	0.811	-0.04
Spring 2006[b]	67	1.88	0.88	58	1.93	0.85	-0.31	0.756	-0.06

Note. Intellectual Challenge scores could range from 1 (lowest rating) to 5 (highest rating). *Difference is statistically significant. Effect size is Cohen's *d*. The composite score does not include Substantive Conversation.
[a]Sixth grade core-content teachers (reading/English language arts, math, science, and social studies).
[b]Seventh grade core-content teachers.

Findings for spring 2006 revealed very small differences between the mean Intellectual Challenge scores for sixth-grade teachers' lessons at immersion (1.72) and control schools (1.75) or for seventh-grade teachers' lessons (immersion, 1.88; control, 1.93). Across all classroom observations, lessons generally failed to intellectually challenge students, with ratings below 2 on the 5-point Intellectual Challenge scale. Seventh-grade teachers' lessons were slightly more challenging than lessons in sixth-grade classrooms. In general, there was scant evidence that the availability of laptop computers and digital resources allowed students to experience more intellectually demanding work.

In addition to analyses for all observed teachers, we also analyzed scores for teachers who were observed in fall 2004 and again in spring 2006. Results in Table 4.6 show that the two-year change in adjusted Intellectual Challenge scores for lessons was statistically insignificant for both teacher groups. Teachers at immersion schools showed a slight increase in the mean intellectual demand of lessons between fall 2004 (1.76) and spring 2006 (1.78), while the mean intellectual challenge of control teachers' lessons decreased (from 1.99 to 1.69). Across all observations, the Intellectual Challenge ratings, which were below 2.0, indicated that the intellectual quality of lessons, on average, was extremely low.

Table 4.6. Adjusted Intellectual Challenge Scores for Sixth-Grade Immersion and Control Teachers with Pre- and Post-Measures

	Fall 2004			Spring 2006			
Group	*N*	Mean	*SD*	Mean	*SD*	*t*-value	*p*
Immersion	26	1.76	0.80	1.78	0.59	0.10	0.923
Control	25	1.99	0.84	1.69	0.70	-1.53	0.138

Note. Intellectual Challenge scores could range from 1 (lowest rating) to 5 (highest rating). The composite score does not include Substantive Conversation.

Conclusions

Even though the level of implementation was generally low at many campuses in the second year, technology immersion positively affected teachers in a number of ways. 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 across time with classroom technology integration and learner-centered practices than control teachers. At the same time, immersion teachers reported generally low and stable resistance to technology.
- Teachers in immersion schools collaborated more often with their peers on technology-related instructional and learning issues than control teachers, and students in immersion classrooms used technology applications more often for core-subject learning activities.
- Across both treatment and control campuses, school poverty was negatively associated with teacher growth on several technology-related indicators. Most importantly, teachers in schools with above average levels of school poverty grew in technology proficiency at a significantly slower rate.
- The availability of technology resources had little, if any, effect on the intellectual challenge of immersion teachers' lessons. Across both immersion and control teachers' classrooms, the intellectual demand of core-subject lessons was typically low.

5. Effects of Technology Immersion on Students and Learning

In the theoretical model for technology immersion, we assume that an improved school environment for technology will lead to teachers who have greater technology proficiency and use technology more often for their own professional productivity. Moreover, in a fully immersed school, teachers have students use technology almost daily in their classrooms, and technology provides a means to enhance the intellectual challenge and relevance of lessons. Given changes in teacher knowledge and practices in an immersion school, we also reason that improved school and classroom environments for technology will lead students to greater technology proficiency and use, more frequent peer collaboration, opportunities for more challenging and relevant school work, stronger engagement in school and learning, and enhanced personal self-direction.

Consistent with our suppositions, findings reported in Chapter 4 confirm that teachers at immersion schools have grown individually in important areas. Immersion teachers, in comparison to their control counterparts, are more technically proficient, use technology more often for professional productivity, express a stronger ideological affiliation with immersion practices, and have their students use technology more often. On the contrary, results also show that student technology activities occur infrequently in immersion teachers' core-content classrooms, and more importantly, new resources generally have failed to advance the intellectual quality of teachers' lessons.

Considering both the encouraging and less promising findings on second-year implementation of technology immersion, we investigate in this section the effects of 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 two cohorts of students. Cohort 1 students completed surveys as sixth graders in fall 2004 and spring 2005, and again as seventh graders in spring 2006. Cohort 2 students completed surveys as sixth graders in fall 2005 and in spring 2006. The *Student Questionnaire* measures students' technology proficiency, technology use, and views on technical problems. The questionnaire also gauges students' opportunities to work with peers in small groups and their satisfaction with school. The *Style of Learning Inventory* (*SLI*) measures 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 82% across administrations. With the exception of spring 2005, there were only slight differences in response rates between cohorts and comparison groups. (See a complete list of response rates in the methodology chapter.)

Sections to follow present findings for the two student cohorts. Results are reported for Cohort 1 students who completed surveys at three time points. For this cohort, we use hierarchical linear modeling (HLM) growth models to examine the effects of technology immersion on students' individual growth rates for various measures. Results also are presented for Cohort 2 students who completed surveys at two time points. For these students, we use HLM to estimate the effects of technology immersion on students' spring 2006 scale scores. For both student groups, immersion effects are estimated for the following scales: Technology Proficiency, Self-Directed Learning, School

Satisfaction, Classroom Activities, Small-Group Work, and Technical Problems. Cronbach's alpha coefficients (measures of internal consistency reliability) for student-level scales ranged from 0.80 to 0.94.

Cohort 1 Students (Seventh Graders)

HLM Growth Analysis

Longitudinal data allowed researchers to examine the nature of student change over time: fall 2004 (baseline), spring 2005 (after the first implementation year), and spring 2006 (after the second implementation year). Analyses contrast the growth trajectories for Cohort 1 students at 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 produce student- and school-specific effects (i.e., the extent to which scale scores vary across time, students, and schools).

Level 1: Repeated-measures model. Level 1 is a repeated-measures model (i.e., survey time within students) 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 student *i* in school *j,* and Survey Time is the point at which students completed surveys (0 = fall 2004, 1 = spring 2005, 2 = spring 2006). 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 2004, and π_{1ij} is the growth rate (rate of change) for student *i* in school *j* per school year. 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) allows 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 examine how students' initial status (β_{00j}) and growth (β_{10j}) vary 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 33.7% to 100%, and with a grand mean of 68.6%). That is, we theorize that being in an immersion school is positively related to students' 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, 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.

Immersion Effects

Analyses involved the estimation of six, three-level HLM growth models. As shown in Table 5.1, we used separate models to estimate the effects of technology immersion on Cohort 1 students' growth rates for their self-perceptions of Technology Proficiency, Self-Directed Learning, and School Satisfaction, as well as measures of their school technology experiences, including Classroom Activities, Small-Group Work, and Technical Problems. Analyses involved a total of 3,100 students who were continuously enrolled in schools since October 2004, with 1,454 at immersion schools and 1,646 at control schools.

Summary results show that technology immersion had positive student effects 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), Cohort 1 students in immersion schools had significantly more positive growth trajectories than control students for three hypothesized effects of immersion. Estimated mean yearly rates of change for both advantaged and disadvantaged students revealed positive growth trends favoring immersion students for Technology Proficiency, Classroom Activities, and Small-Group Work. Moreover, although immersion students used computers and the Internet more often than control students, there was no significant difference between groups in their tendencies for reporting Technical Problems.

In contrast, the technology immersion model 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 School Satisfaction. Contrary to expectations, we found that as students in both the treatment and control groups advanced from sixth to seventh grade, they reported being less self-directed learners and expressed less satisfaction with school, and there were no statistically significant differences between the comparison groups.

Table 5.1. Cohort 1 (Seventh Graders): Immersion Effects on Estimated Mean Growth Rates for Student Mediating Variables

Scale Scores	Immersion Effect Net of Student and School Poverty	Immersion Yearly Growth Rate		Control Yearly Growth Rate	
		Advantaged Students	Dis-advantaged Students	Advantaged Students	Dis-advantaged Students
Student Self-Perceptions					
Technology Proficiency (5-pt)	Yes***	0.41	0.47	0.21	0.27
Self-Directed Learning (7-pt)	No	-0.09	-0.12	-0.07	-0.10
School Satisfaction (5-pt)	No	-0.08	-0.05	-0.09	-0.06
School Technology					
Classroom Activities (5-pt)	Yes***	0.35	0.41	0.03	0.09
Small-Group Work (5-pt)	Yes***	0.07	0.13	-0.11	-0.04
Technical Problems (5-pt)	No	0.18	0.24	0.10	0.16

Source: Student surveys completed in fall 2004, spring 2005, and spring 2006.
Note. ***$p < .001$. Items measured on either a 5-point or 7-point scale.

Student responses to specific scales, as presented below, help to explain the outcomes for both economically advantaged and disadvantaged students in immersion and control schools.

Student Self-Perceptions

Statistical details for the HLM growth models related to student self-perceptions of their technology proficiency, self-directed learning, and school satisfaction are reported in Table 5.2. Results show that across the student mediating variables, the extent of school poverty had either no discernable effect or a minimally significant association with students' initial status and growth rates. In contrast, a student's poverty (i.e., economically disadvantaged status), was a significantly negative predictor of students' initial status for Technology Proficiency and School Satisfaction, but a significantly positive predictor of students' rate of change for the two variables. Individual scales are discussed below.

Table 5.2. Cohort 1 (Seventh Graders): Immersion (Fixed) Effect Analyses for Student Self-Perception Variables

	Technology Proficiency		Self-Directed Learning[a]		School Satisfaction	
	Gamma Coefficient	*t*-value	Gamma Coefficient	*t*-value	Gamma Coefficient	*t*-value
Initial status (fall 2004)	3.031	51.89***	4.551	107.67***	3.807	92.69***
Immersion	-0.037	-0.44	0.105	2.08*	0.047	1.18
School Poverty	0.000	-0.14	0.003	2.26*	0.000	-0.21
Student Disadvantage	-0.361	-9.12***	-0.039	-1.07	-0.091	-2.89**
Growth rate	0.210	8.08***	-0.068	-3.59**	-0.094	-4.92***
Immersion	0.198	4.53***	-0.025	-1.04	0.016	0.72
School Poverty	-0.001	-0.52	-0.001	-0.82	0.001	2.23*
Student Disadvantage	0.060	3.49**	-0.029	-1.60	0.033	2.18*

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

[a]Immersion students had significantly higher initial self-directed learning scores. A latent variable regression, controlling for the effect of this initial difference on the growth rate, indicated that the difference between the original and adjusted immersion coefficients was not significant (the difference divided by the standard error of the difference = 1.44).

Technology Proficiency. As a measure of their 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 in Figure 5.1 compare the Technology Proficiency growth trajectories for students in immersion and control schools. As the figure shows, both advantaged and disadvantaged immersion students, grew in technology proficiency at a significantly faster rate than their student counterparts in control schools. The yearly rates of change in proficiency for economically advantaged and disadvantaged students in immersion schools were 0.41 and 0.47 scale-score points, respectively. This compares to 0.21 and 0.27 scale-score points, respectively, for advantaged and disadvantaged control students. Thus, economically disadvantaged students in immersion schools who began in fall 2004 with lower levels of technology proficiency surpassed even advantaged control students in proficiency by the end of seventh grade.

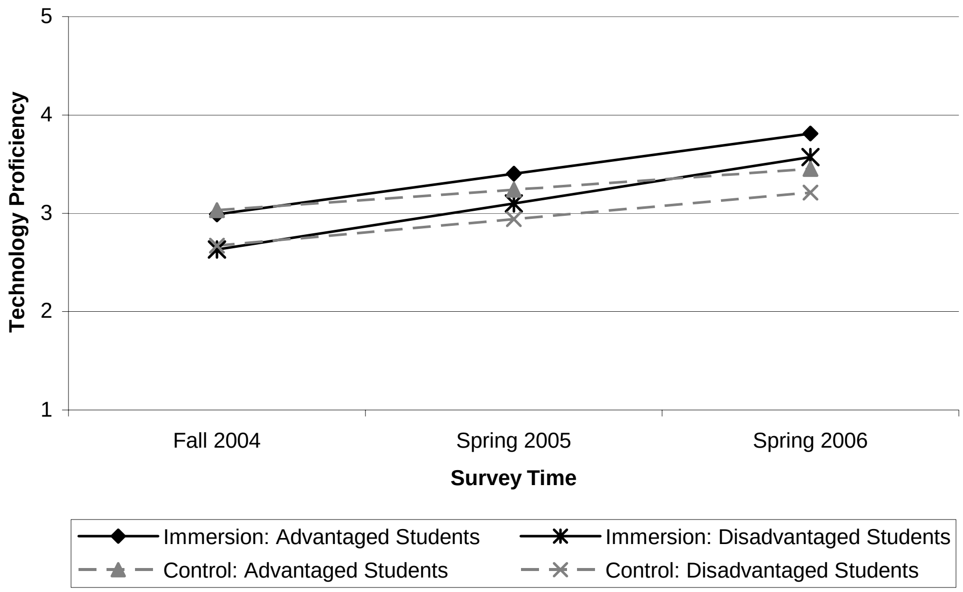

Figure 5.1. Estimated mean Technology Proficiency growth trajectories for economically advantaged and disadvantaged student groups in immersion and control schools.

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 suggests that the individualized learning opportunities allowed through one-to-one technology will positively affect students' self-regulated learning, our results revealed no significant immersion effect on students' growth in self-direction. Initially, all sixth graders expressed ambivalent affiliations with self-regulating statements such as, "When a big project or report is assigned, I make a mental or written schedule to make sure everything gets done on time." Students, on average, reported that such statements were, at best, only a *little true*. As both immersion and control students progressed through seventh grade, their responses to statements revealed a significantly negative growth trend. The estimated yearly rates of change in self-direction for advantaged and disadvantaged students in immersion schools were -0.09 and -0.12 scale-score points, respectively, compared to -0.07 and -0.10 scale-score points, respectively, for their control-group counterparts. Overall findings suggest that seventh graders generally do 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 significantly lower levels of school satisfaction across time. The estimated yearly rates of change in satisfaction for immersion and control schools were nearly identical (-0.08 and -0.09 scale-score points, respectively, for advantaged students; -0.05 and -0.06 for disadvantaged students).

School Technology

Statistics for the HLM growth models that estimate effects on students' technology experiences are reported in Table 5.3. Coefficients show that the level of school poverty had no significant association with either students' initial status or their growth rates for technology-related scores. On the other hand, a student's poverty was a significantly positive predictor of students' growth in the frequency of classroom activities involving technology, as well as increased technical problems using computers. Findings for specific scales are discussed below.

Table 5.3. Cohort 1 (Seventh Graders): Immersion (Fixed) Effect Analyses of School Technology Variables

	Classroom Activities (with technology)		Small-Group Work		Technical Problems[a]	
Dependent variable and predictor	Gamma Coefficient	*t*-value	Gamma Coefficient	*t*-value	Gamma Coefficient	*t*-value
Initial status (fall 2004)	2.039	33.02***	2.826	51.64***	2.362	39.94***
Immersion	0.133	1.64	0.001	0.01	-0.140	-1.88†
School Poverty	-0.002	-0.72	-0.002	-0.90	-0.003	-1.17
Student Disadvantage	0.005	0.17	-0.049	-0.86	-0.078	-1.33
Growth rate	0.031	1.17	-0.105	-3.89**	0.100	3.30**
Immersion	0.323	5.46***	0.173	4.05***	0.084	1.55
School Poverty	0.000	0.09	0.000	-0.20	0.001	0.36
Student Disadvantage	0.058	2.83**	0.063	1.86†	0.060	2.08*

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

[a]Immersion students had borderline significantly lower initial technical problems scores. A latent variable regression, controlling for the effect of this initial difference on the growth rate, indicated that the difference between the original and adjusted immersion coefficients was not significant (the difference divided by the standard error of the difference = 1.76).

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 the frequency of technology use on a 5-point scale ranging from 1 (*never*) to 5 (*almost daily*). As anticipated given the increased 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 (see Figure 5.2).

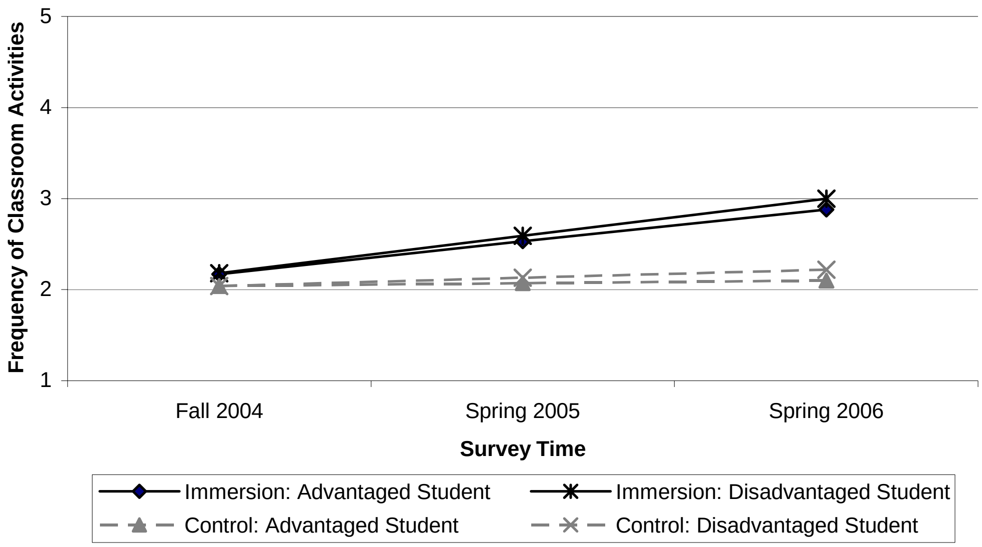

Figure 5.2. Estimated mean growth trajectories for the frequency of Classroom Activities by economically advantaged and disadvantaged student groups in immersion and control schools.

The yearly rates of change in Classroom Activities involving technology for economically advantaged and disadvantaged immersion students were 0.35 and 0.41 scale-score points, respectively. In contrast, advantaged and disadvantaged control students had relatively flat rates of change for classroom technology use (0.03 and 0.09 scale-score points, respectively). Despite significant increases in technology use by immersion students, however, mean use statistics suggest that students use various technology applications infrequently (about once or twice a month).

Small-Group Work. Research studies consistently link one-to-one technology with a more collaborative classroom environment. Thus, our survey 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 show that students in immersion schools reported increasing opportunities for small-group work with peers across time (significant yearly growth rates of 0.07 and 0.13 scale-score points for advantaged and disadvantaged students, respectively). Quite the opposite, students at control campuses reported less frequent small-group activities across survey times (negative yearly growth rates of -0.11 and -0.04 scale-score points for advantaged and disadvantaged students, respectively).

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 about how often various Technical Problems happened when they tried to use a computer at school. Students rated the frequency of problems on a 5-point scale As a whole, students reported significantly more frequent problems with technology as they advanced from sixth to seventh grade, but there were no significant differences between the growth in technology-related problems for immersion and control students.

Cohort 2 Students (Sixth Graders)

We analyzed the effects of immersion on Cohort 2 students' scale scores for mediating variables using two-level hierarchical linear models.

HLM Analyses

Level 1: Student-level model. In the student-level model, spring 2006 scale scores from surveys were regressed on fall 2005 scale scores, economic status (0 if not disadvantaged, 1 if disadvantaged), African American status (0 if not African American, 1 if African American), Hispanic status (0 if not Hispanic, 1 if Hispanic) and gender (0 if male, 1 if female). That is,

$$Y_{ij} = \beta_{0j} + \beta_{1j}(\textit{Fall 2005 scale score}) + \beta_{2j}(\textit{Disadvantaged}) + \beta_{3j}(\textit{African American}) + \beta_{4j}(\textit{Hispanic}) + \beta_{5j}(\textit{Female}) + r_{ij.}$$

Level 2: School-level model. A school-level model was developed to answer the question of whether immersion schools had higher scale scores than control schools, after controlling for initial scale scores, economic status, ethnicity, gender, and school-level poverty. That is,

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(\textit{Immersion dummy}) + \gamma_{02}(\textit{School Poverty}) + \mu_{0j.}$$

Immersion was an indicator variable with a value of 1 for an immersion school and a value of 0 for a control school. School poverty was a continuous variable with percentages ranging from 33.7% to 100%, and a grand mean of 68.6%.

Immersion Effects

Analyses involved the estimation of six, two-level HLM models. As shown in Table 5.4, we used separate models to estimate the effects of technology immersion on Cohort 2 students' spring 2006 scores for their self-perceptions of Technology Proficiency, Self-Directed Learning, and School Satisfaction, as well as measures of school technology, including Classroom Activities, Small-Group Work, and Technical Problems. Analyses involved a total of 4,033 students who were continuously enrolled in schools since October 2005, with 1,988 at immersion schools and 2,045 at control schools.

Table 5.4. Cohort 2 (Sixth Graders): Immersion Effects on Student Mediating Variables

Scale	Immersion Effect Net of Fall Score, Student Demographic Characteristics, & School Poverty	Magnitude of Effect (*d*) in Standard Deviation Units
Student Self-Perceptions		
Technology Proficiency	Yes**	0.30 (small)
Self-Directed Learning	No	-0.03 (trivial)
School Satisfaction	No	-0.01 (trivial)
School Technology		
Classroom Activities	Yes***	0.83 (large)
Small-Group Work	Yes**	0.25 (small)
Technical Problems	No	0.05 (trivial)

Source: Student surveys conducted in fall 2005 and spring 2006.
Note. $^{**}p < .01$; $^{***}p < .001$. Effect size is Cohen's *d* value. The interpretation is that an effect size greater than 0.5 is large, 0.5-0.3 is moderate, 0.3-0.1 is small, and anything smaller than 0.1 is trivial.

Summary results presented in Table 5.4 for Cohort 2 sixth graders show that technology immersion had significantly positive effects for the same mediating variables as reported for Cohort 1 students (seventh graders). After adjusting for fall 2005 scale scores, student demographic characteristics (gender, ethnicity, economic disadvantage), and school poverty (percentage of economically disadvantaged students), technology immersion had a significantly positive effect on students' 2006 scale scores for Technology Proficiency, Classroom Activities, and Small-Group Work. The immersion effect was larger for the frequency of Classroom Activities with technology (effect size

[ES] = 0.83) and smaller for students' ratings of their Technology Proficiency (ES = 0.30) and frequency of Small-Group Work (ES = 0.25). Conversely, there were no significant effects of immersion on Cohort 2 students' Self-Directed Learning, School Satisfaction, or frequency of Technical Problems. Statistical details for HLM analyses are provided in Tables 5.5 and 5.6.

In addition to differences between immersion and control groups, results for HLM analyses reported in Tables 5.5 and 5.6 revealed notable associations between the demographic characteristics of sixth graders and technology-related variables. Results indicate that:

- *Female students* (net of fall scores, economic status, ethnicity, and school poverty) had significantly higher spring 2006 scores than males for Technology Proficiency and School Satisfaction, as well as the frequency of Small-Group Work in core classes.
- *Economically disadvantaged students* (net of fall scores, gender, ethnicity, and school poverty) had significantly lower spring 2006 scores than advantaged students for Technology Proficiency and School Satisfaction. Additionally, being an economically disadvantaged student was negatively associated with almost all mediating variables.
- *Hispanic students* (net of fall scores, gender, economic status, and school poverty) had significantly lower spring 2006 scores than non-minority students on Technology Proficiency, but significantly higher ratings of School Satisfaction as well as the frequency of Small-Group Work in core-subject classes.
- *African American students* (net of fall scores, gender, economic status, and school poverty) had significantly lower spring 2006 scores than non-minority students on Technology Proficiency, but students reported a significantly greater frequency of Classroom Activities involving technology and Small-Group Work in core-subject classes.

Findings for the second year continue to show that females rate their technology proficiency higher than males, and females express greater satisfaction with the kind of academic work they do in middle schools. Moreover, although immersion is closing the technology equity gap between advantaged and disadvantaged students, overall results show that economically disadvantaged students and more impoverished schools remain at risk due to lower student technical proficiency, lower levels of school satisfaction, and lower levels of technical support for computer use. For the ethnic groups, outcomes are mixed but suggest that students' school and classroom experiences differ.

Table 5.5. Cohort 2 (Sixth Graders): Immersion (Fixed) Effect Analyses of Student Self-Perception Variables

	Technology Proficiency		Self-Directed Learning		School Satisfaction	
	Gamma Coefficient	*t*-value	Gamma Coefficient	*t*-value	Gamma Coefficient	*t*-value
Intercept	3.229	60.01***	4.593	155.85***	3.688	110.37***
Immersion	0.251	3.52**	-0.023	-0.73	-0.008	-0.23
School poverty	0.001	0.71	0.001	1.69†	-0.001	-1.20
Female	0.074	4.19***	0.030	1.15	0.113	4.44***
Hispanic	-0.064	-2.31*	-0.029	-0.98	0.068	2.28*
African American	-0.111	-2.29*	0.037	0.90	0.073	1.00
Disadvantaged	-0.125	-3.63**	-0.027	-1.03	-0.092	-3.42**
Fall 2005 score	0.477	20.72***	0.556	27.70***	0.345	15.23***

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

Table 5.6. Cohort 2 (Sixth Graders): Immersion (Fixed) Effect Analyses of School Technology Variables

	Classroom Activities (with technology)		Small-Group Work		Technical Problems	
	Gamma Coefficient	*t*-value	Gamma Coefficient	*t*-value	Gamma Coefficient	*t*-value
Intercept	2.118	34.77***	2.610	45.61***	2.361	39.92***
Immersion	0.663	7.17***	0.214	3.17**	0.046	0.61
School poverty	0.003	1.03	0.001	0.26	0.005	2.22*
Female	-0.003	-0.13	0.096	2.91**	0.013	0.49
Hispanic	0.048	1.33	0.092	2.06*	-0.055	-1.49
African American	0.142	3.15**	0.197	3.75***	0.074	1.17
Disadvantaged	0.014	0.42	-0.009	-0.24	-0.043	-1.38
Fall 2005 score	0.234	16.55***	0.227	11.65***	0.202	7.42***

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

Immersion Effects on Student Engagement

Based on our literature review, we theorized that students who attended schools immersed in technology would express higher levels of school satisfaction. Additionally, we anticipated that increased technology access and use would lead to improved student conduct, and consequently, fewer discipline problems and increased school attendance. Findings on student engagement presented below show that students in immersion schools exhibited significantly stronger school engagement on one indicator and significantly less engagement on another.

School Satisfaction

Students' satisfaction with school provides one measure of engagement, and as reported earlier in the HLM analyses, there was no significant immersion effect on students' School Satisfaction for either Cohort 1, seventh graders or Cohort 2, sixth graders. Students in immersion and control schools expressed correspondingly modest levels of satisfaction with the kinds of work they do in classes and the relevance of their schoolwork (about 3.7 on the 5-point scale, on average).

Student Discipline and Behavior

As another measure of engagement, we collected student-level data from schools on disciplinary actions occurring during the 2005-06 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. Accordingly, we compared the frequency of the Disciplinary Action Reports (PEIMS 425 records) submitted for each student during the 2005-06 school year for treatment and control schools. Findings for student cohorts presented in Figure 5.3 show that students in immersion schools had proportionately fewer behavioral and disciplinary problems than their counterparts in control schools.

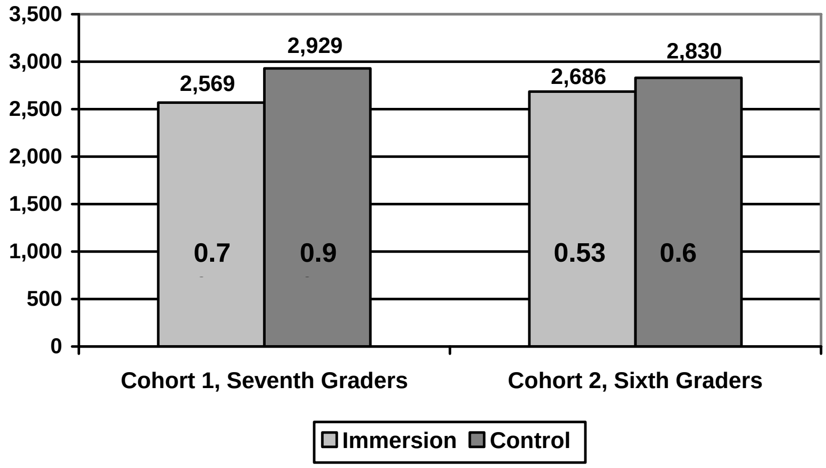

Figure 5.3. Number of students and average number of disciplinary actions for Cohort 1 (7th graders) and Cohort 2 (6th graders) attending immersion and control schools.

Cohort 1 seventh graders at immersion schools had significantly fewer disciplinary actions than students at control schools ($t = 2.24$, $p < 0.03$). Specifically, 2,929 control-group students had an average of 0.90 disciplinary actions compared to 2,569 immersion students who had an average of 0.76 disciplinary actions. The effect size for the mean difference (0.14), however, was extremely small ($d = 0.06$). Similarly, Cohort 2 sixth graders at immersion schools had significantly fewer disciplinary actions than students at control schools ($t = 3.04$, $p < 0.002$). In particular, 2,830 control-group students had an average of 0.69 disciplinary actions, and 2,686 immersion students who had an average of 0.53 disciplinary actions. Again, the effect size for the mean difference (0.16) was very small ($d = 0.08$).

Overall, second-year findings on student discipline and behavior mirror results for the first project year. Evidence shows that both sixth and seventh graders attending technology immersion schools had fewer disciplinary and behavior problems than their counterparts in control schools. Although the estimated size of the differences between comparison groups is considered statistically trivial, having fewer disciplinary actions per student in middle schools may have practical benefits in terms of day-to-day time and effort.

Student Attendance

School attendance rates (absolute values). Another indicator of school engagement is students' school attendance. Accordingly, we compared the annual attendance rates for Cohort 1 immersion- and control-group students for the year prior to project implementation and for the two implementation years. We compared Cohort 2 students' attendance for the year prior to project implementation and after one implementation year. Results in Table 5.7 show that the average attendance rates of students in immersion schools are approximately 0.3 to 0.8 percentage points lower than the attendance rates of control students. The attendance-rate gap was present before project implementation and the difference widened after the implementation of technology immersion.

Table 5.7. School Attendance Rates for Cohort 1 and Cohort 2 Students

Year/Grade	Immersion		Control		
	Mean	SD	Mean	SD	*Difference*
Cohort 1 (7th)					
2003-04	97.09	3.72	97.36	3.25	-0.27
2004-05	96.57	4.00	96.82	3.48	-0.25
2005-06	95.67	5.21	96.47	4.07	-0.80
Cohort 2 (6th)					
2004-05	96.89	4.04	97.19	3.37	-0.30
2005-06	96.19	4.54	96.75	3.82	-0.56

Source: Individual student data from TEA.
Note. Cohort 1 included 1,978 immersion and 2,320 control students with attendance data from 2004 to 2006. Cohort 2 included 2,287 immersion students and 2,485 control students with attendance data for 2005 and 2006.

HLM analyses of attendance. To test the effects of immersion on student attendance, while controlling for school and student characteristics, we conducted HLM analyses. For Cohort 1, longitudinal data allowed researchers to use a three-level HLM growth model to examine changes in school attendance rates over time: 2003-04 (baseline), 2004-05 (after one year), and 2005-06 (after two years). For Cohort 2 students, we used a two-level HLM model to examine the effects of immersion on schools' 2005-06 attendance rate. Table 5.8 presents the HLM statistics for both student cohorts.

Table 5.8. Immersion (Fixed) Effect Analyses of Student Attendance

Group	School-Level Analysis	Gamma Coefficient	*t*
Cohort 1 (7th Graders)			
3-Level HLM Growth Model	Initial attendance (2004)	97.076	616.69***
	Immersion	-0.053	-0.24
	School poverty	0.022	4.41***
	Disadvantaged	-0.702	-5.31***
	Growth rate	-0.355	-5.27***
	Immersion	-0.217	-2.18*
	School poverty	-0.005	-1.84†
	Disadvantaged	-0.154	-1.86†
Cohort 2 (6th Graders)			
2-Level HLM Model	Intercept	96.922	520.22***
	Immersion[a]	-0.268	-1.83†
	School poverty	0.001	0.25
	Prior attendance	0.627	20.73***
	Disadvantaged	-0.560	-3.83***
	Female	0.242	1.81†
	Hispanic	0.115	0.55
	African American	-0.329	-0.85

†$p < .10$; *$p < .05$; **$p < .01$; ***$p < .001$.
[a]The effect size was 0.07. Although statistically significant, this effect was trivial in magnitude. The interpretation is that an effect size greater than 0.5 is large, 0.5-0.3 is moderate, 0.3-0.1 is small, and anything smaller than 0.1 is trivial.

Contrary to expectations, results indicate that technology immersion has a significantly negative effect on students' school attendance. Analyses for Cohort 1 (seventh graders) estimated immersion effects on schools' adjusted average rates of attendance (controlling for student and school poverty). As Figure 5.4 illustrates, average school attendance rates for economically advantaged immersion- and control-group students in schools with average rates of school poverty decreased as students advanced from fifth to seventh grade. The yearly estimated negative rate of change in attendance for immersion students (-0.57 percentage points) was greater than the annual change for control students (-0.36 percentage points). Thus, at the end of seventh grade, advantaged students in immersion schools had an estimated average attendance rate of 95.88% percent compared to 96.37% for control students, with the statistically significant difference favoring control students ($t = -2.18$, $p < .05$). Attendance rates for economically disadvantaged students decreased at an even faster pace, with yearly negative change rates for disadvantaged students in immersion schools greater than the declining rates for control students (-0.73 percentage points versus -0.51, respectively).

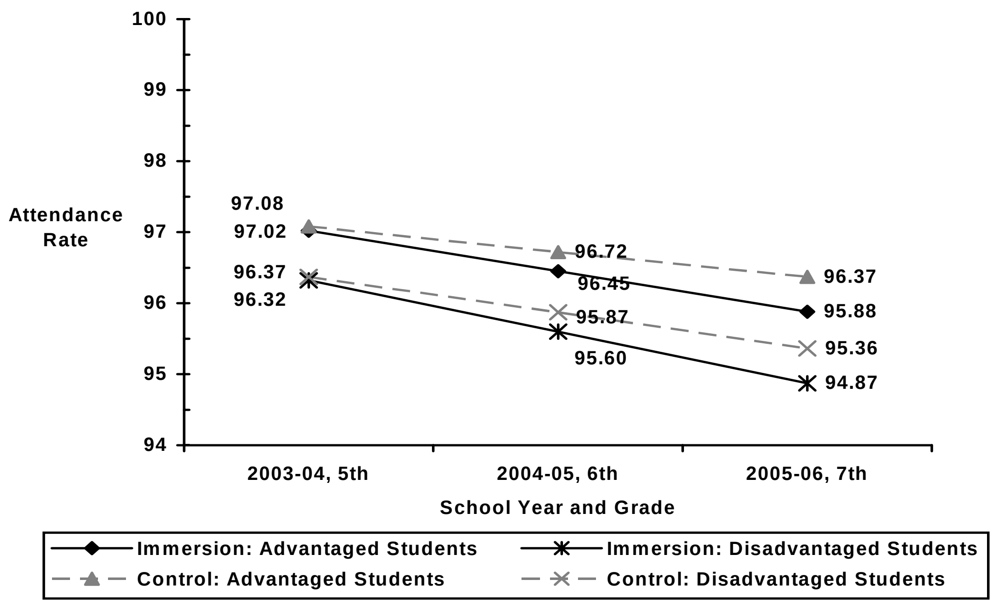

Figure 5.4. Estimated attendance rates for economically advantaged and disadvantaged Cohort 1 students in immersion and control schools with average rates of school poverty.

Results for Cohort 2 students presented in Table 5.8 show that average school attendance rates for the sixth-grade students declined as they moved from elementary to middle school. The difference in estimated average attendance rates for students in immersion and control schools is statistically significant ($t = -1.83$, $p < .10$), but the size of the difference (-0.27 percentage points) is practically very small.

Overall, there was no "boost" in school attendance for students in immersion schools. Instead, school attendance decreased at immersion campuses and the attendance gap between students in immersion and control schools increased across school years. It is difficult to explain why the presence of one-to-one technology would have a negative effect on student attendance. Further investigation of student attendance patterns will be needed to provide insight into student behaviors.

Conclusions

In the second project year, we investigated the effects of technology immersion on students and learning for Cohort 1 (seventh graders) and Cohort 2 (sixth graders). Data from two student cohorts allowed researchers to examine the constancy of results across groups, and indeed, we found consistent outcomes for mediating variables. Key findings are the following.

- Technology immersion positively affects students' technology proficiency. Immersion students grew in proficiency at a significantly faster rate or to a higher level than control students. Immersion substantially closed the technology equity gap for economically disadvantaged students.
- Technology immersion positively affects students' classroom technology use and interactions with peers. Students in immersion schools used various technology applications significantly more often in their core-subject classrooms than control students, and they had significantly more frequent opportunities to learn in small groups with their classmates.
- Even though immersion students had increased access to technology and used technology more often, they reported technical problems when using computers at school at a similar frequency as control students.
- Immersion students, 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 seventh grade they reported significantly less self-directed learning behaviors.
- Technology immersion positively affects 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.
- The school attendance rates for immersion students were significantly lower than attendance rates for control-group students.
- Immersion and control-group students expressed similar levels of school satisfaction, with both groups reporting significantly lower levels of school satisfaction across time.

6. Effects of Technology Immersion on Student Achievement

Technology immersion aims ultimately to increase 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). Accordingly, we theorize that students who are enrolled in fully immersed schools will experience school and classroom environments that promote stronger individual learning and technology proficiencies, more intellectually challenging work, and enhanced engagement in school and learning. In turn, changes in students and their learning experiences will contribute to enhanced performance on state assessments. In the second year of the technology immersion project, as detailed in previous report chapters, we have cited noteworthy outcomes in some areas (e.g., increases in teachers' technology knowledge and the frequency of classroom technology use, as well as improvements in students' technology proficiency and school behavior). At the same time, we have noted that low project implementation levels at many schools may have diminished immersion's potential impact on student achievement during the project's second year. Given existing contextual conditions, the following sections present academic achievement results for Cohort 1 and Cohort 2 students who were enrolled continuously in the 21 immersion and 21 control schools through TAKS testing in April 2006.

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). The TAKS assesses reading and mathematics at grades 6 and 7 and writing at grade 7. This study uses several types of TAKS scores.

- **Met the standard.** This score represents satisfactory academic achievement. Students who meet this standard performed at a level that was at or somewhat above the state passing standard. Thus, students demonstrated a sufficient understanding of the knowledge and skills measured at the grade level.
- **Commended performance.** This score represents high academic achievement. Students who meet this standard performed at a level that was considerably above the state passing standard. Therefore, students demonstrated a thorough understanding of the knowledge and skills measured at 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 adopted a phase-in plan for implementing increasingly rigorous passing standards on the TAKS. In 2002-03, passing was set at two standard errors of measurement (SEM) below the passing standard recommended by the State Board of Education panel. In 2004-05, passing standards for reading, mathematics, and writing were fully implemented. Thus, for this study, TAKS scores for 2003-04 have been converted to reflect the panel recommended passing standard.

Standard Scores

In addition to the scores provided by the TEA, researchers generated standard scores that are 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.

A major disadvantage 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

Cohort 1 (Seventh Graders)

One measure of student academic outcomes is their progress toward meeting TAKS passing and commended performance standards. Information in Table 6.1 compares the absolute performance of Cohort 1 students in immersion and control schools across three TAKS testing years.

Table 6.1. Cohort 1 (Seventh Graders):
TAKS Passing and Commended Performance Rates for Reading and Mathematics

TAKS Test	Group	N	2004 Grade 5 Percent	2005 Grade 6 Percent	2006 Grade 7 Percent	*2006-2004 Difference*
Met Standard						
Reading	Immersion	1,569	66.4	74.1	70.5	4.1
	Control	1,842	71.8	80.9	75.7	3.9
Mathematics	Immersion	1,591	68.9	60.3	63.0	-5.9
	Control	1,850	71.4	66.5	65.1	-6.3
Commended Performance						
Reading	Immersion	1,569	18.9	27.5	16.3	-2.6
	Control	1,842	21.9	34.1	17.5	-4.4
Mathematics	Immersion	1,591	23.1	18.3	10.1	-13.0
	Control	1,850	23.2	20.3	8.9	-14.3

Source: Analysis of individual student data from TEA.
Note. The 2004 passing rates are based on 2005 standards. Students had TAKS scores in 2004, 2005, and 2006 and attended the same schools.

Results show that Cohort 1 seventh graders at immersion schools had somewhat lower passing rates in spring 2006 for TAKS reading and mathematics than students at control campuses. However, TAKS-score comparisons between 2004 (5th grade baseline) and 2006 (7th grade) revealed similar gains or losses across immersion and control groups, respectively, for both TAKS reading (4.1 percentage points versus 3.9 points) and mathematics (-5.9 percentage points versus -6.3 points). Comparison-group trends for Commended Performance generally reflect results for students who met the grade-level passing standard. The percentage of students achieving commended TAKS standards, at both treatment and control schools, varied greatly across testing periods. Students had the greatest difficulty meeting commended standards for mathematics.

Cohort 1 students at immersion schools also had lower TAKS passing rates for writing in 2006 than control students, and students' TAKS-score gains between 2003 (4th grade baseline) and 2006 (7th grade) were larger for control-group students (11.4 percentage points versus 9.6 points for immersion schools). Control students also achieved Commended Performance in writing at a higher rate and had stronger 4th-to-7th-grade gains than immersion students (25.5 percentage points versus 19.6 points).

Table 6.2. Cohort 1 (Seventh Graders):
TAKS Passing and Commended Performance Rates for Writing

TAKS Test	Group	N	2003 Grade 4 Percent	2006 Grade 7 Percent	*2006-2003 Difference*
Met Standard					
Writing	Immersion	1,445	79.3	88.9	9.6
	Control	1,681	81.9	93.3	11.4
Commended Performance					
Writing	Immersion	1,445	11.1	30.7	19.6
	Control	1,681	11.4	36.9	25.5

Source: Analysis of individual student data from TEA.
Note. The 2003 passing rates are based on 2005 standards. Students had TAKS scores in 2003 and 2006 and attended the same schools.

Cohort 2 (Sixth Graders)

Table 6.3 presents Cohort 2 students' passing rates for TAKS reading and mathematics. Sixth graders at immersion schools had somewhat lower passing rates in spring 2006 for TAKS reading and mathematics than students at control campuses. However, TAKS passing rate differences between 2005 (5th grade baseline) and 2006 (6th grade) favored students at immersion schools in both reading (20.3 percentage points versus 16.9 points for control students) and mathematics (-1.7 percentage points versus -4.1 points for control students). Trends for Commended Performance showed higher 2006 achievement rates for control students, but year-to-year differences between treatment and control groups were mixed.

Table 6.3. Cohort 2 (Sixth Graders in 2005-06)
TAKS Passing and Commended Performance Rates for Reading and Mathematics

TAKS Test	Group	N	2005 Grade 5 Percent	2006 Grade 6 Percent	*2006-2005 Difference*
Met Standard					
Reading	Immersion	1,789	65.8	86.1	20.3
	Control	2,000	73.3	90.2	16.9
Mathematics	Immersion	1,805	71.6	69.9	-1.7
	Control	2,033	77.7	73.6	-4.1
Commended Performance					
Reading	Immersion	1,789	16.4	28.0	11.6
	Control	2,000	18.9	33.1	14.2
Mathematics	Immersion	1,805	21.2	20.6	-0.6
	Control	2,033	24.6	21.5	-3.1

Note. Students had TAKS scores in 2005 and 2006 and attended the same schools.

Altogether, TAKS passing rates for reading, mathematics, and writing 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 effect of immersion on student 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 immersion and control students before and after two school years of project implementation (Cohort 1, seventh graders) and one school year of implementation (Cohort 2, sixth graders). Immersion effects for Cohort 1 are estimated for TAKS reading, mathematics, and writing *T* scores. Longitudinal scores for TAKS reading and mathematics allowed researchers to examine changes in students’ achievement over time: 2004 (5th grade baseline), 2005 (6th grade), and 2006 (7th grade). These analyses estimated immersion effects using three-level HLM growth models. For TAKS writing, Cohort 1 students’ scores were available for two time points: 2003 (4th grade baseline) and 2006 (7th grade). Accordingly, data analysis involved a two-level HLM model. Similar to writing, the effects of immersion on Cohort 2, sixth graders’ TAKS reading and mathematics *T* scores were analyzed using two-level HLM models. Cohort 2 students had TAKS scores for 2005 (5th grade baseline) and 2006 (6th grade). (See Appendix E for technical detail on the HLM models.)

Cohort 1 (Seventh Graders)

TAKS Reading and Mathematics

The analyses that follow contrast the estimated achievement growth trajectories for Cohort 1 students in immersion and control schools. Three-level HLM growth models allowed researchers to examine 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 enabled us to capture the key features of growth (e.g., initial status, rate of change). Time is the point at which students completed surveys (0 = fall 2004, 1 = spring 2005, 2 = spring 2006). The level 2 model (between-students model) allowed us to determine 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 immersion (1 = immersion, 0 = control group) and school poverty (percentage of economically disadvantaged students attending a school). School poverty rates ranged from about 34% to 100%, with a mean of 68.6%. Thus, we hypothesized that being in an immersion school is positively related to students’ growth in achievement, after controlling for the poverty level of the school.

Table 6.4 shows the results of the HLM growth analysis for Cohort 1 students. We generated two separate models to estimate the effects of immersion on students’ growth in reading achievement and mathematics achievement. We 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 and mathematics learning. Analyses involved approximately 1,590 immersion students and 1,860 control students. Comparison groups had nearly equivalent proportions of students included in longitudinal analyses (about 66.5% for immersion and 65.5% for control).

Table 6.4. Data for Cohort 1 (Seventh Graders): Effects of Immersion (Fixed) on TAKS Reading and Mathematics Achievement Growth Rates

Dependent variable and predictor	TAKS Reading $N = 3{,}419$		TAKS Mathematics $N = 3{,}450$	
	Gamma Coefficient	*t*-value	Gamma Coefficient	*t*-value
Initial mean status (2004 TAKS *T* score)	53.834	84.75***	52.813	80.17***
Immersion[a]	-1.350	-2.08*	-1.074	-1.30
School poverty	-0.064	-4.71***	-0.047	-2.61*
Economic disadvantage	-6.384	-9.58***	-4.558	-9.01***
Growth rate	-0.547	-2.87**	-0.315	-1.19
Immersion[a]	0.257	1.05	0.220	0.49
School poverty	0.007	0.84	0.008	0.61
Economic disadvantage	0.461	2.41*	-0.285	-1.91†

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

[a]Immersion students had significantly lower initial TAKS reading scores. A latent variable regression, controlling for the effect of this initial difference on the growth rate, indicated that the difference between the original and adjusted immersion coefficients was not significant (the difference divided by the standard error of the difference = 0.26).

As can be seen in the table, the initial mean TAKS reading status for the reference group (an economically advantaged student in a control school with an average level of school poverty) is estimated at 53.83 (the mean 2004 TAKS reading *T* score). The coefficient representing immersion (-1.350) shows that students in immersion schools had somewhat lower initial TAKS reading *T* scores (51.74) 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 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 (-6.384 and -0.064 *T*-score points, respectively).

After controlling for student and school levels of poverty, results in Table 6.4 show that there was no statistically significant effect of immersion on students' growth rate for TAKS reading scores. Statistics show that advantaged students in control schools (with average poverty) began with a mean TAKS *T* score of 53.83 and their reading achievement decreased by about 0.55 *T*-score point per year (significant coefficient of -0.547). The positive coefficient for immersion (0.257) shows that reading scores for advantaged students in immersion schools (with average poverty) decreased at a slightly slower rate compared to control schools—0.29 *T*-score point per year (-0.547 + 0.257 = -0.290). Economically disadvantaged students in both immersion and control schools grew in reading achievement at a significantly faster rate than their more advantaged peers. Figure 6.1 illustrates the estimated mean TAKS reading growth trajectories for advantaged and disadvantaged students by school comparison group.

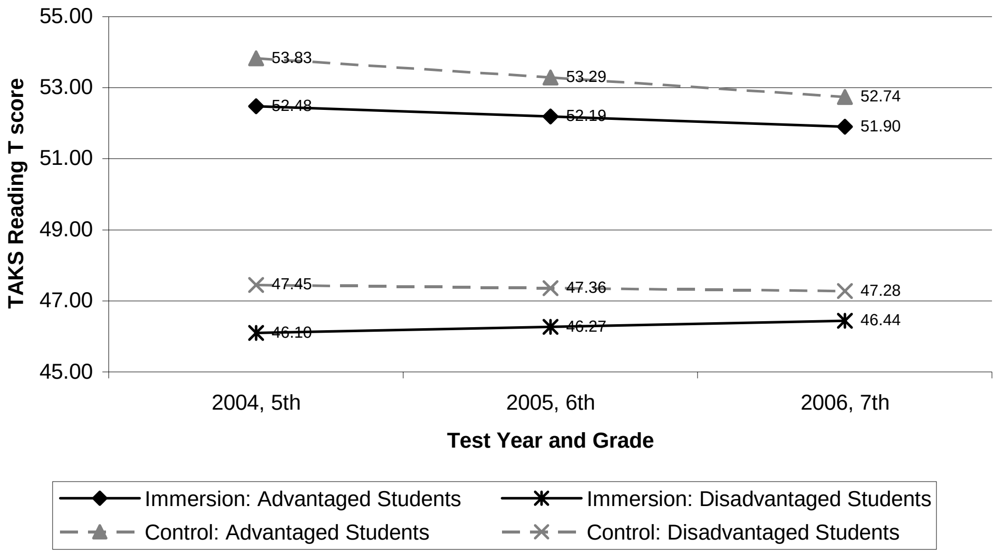

Figure 6.1. Estimated mean TAKS reading achievement growth trajectories for economically advantaged and disadvantaged student groups in immersion and control schools. Differences between immersion and control groups are statistically insignificant.

Results in Table 6.4 for Cohort 1 students' initial status in TAKS mathematics generally mirror findings for reading. Control students in the reference group began with an estimated mean mathematics *T* score of 52.81. Their immersion student counterparts initially had a similar estimated mathematics *T* score (51.74). Economically disadvantaged students and students attending schools with above average levels of poverty started significantly behind their more advantaged peers in math ability (-4.558 and - 0.047 *T*-score points, respectively).

Similar to results for TAKS reading, after controlling for student and school levels of poverty, there was no significant effect of immersion on students' growth rate for TAKS mathematics scores. Estimated math achievement for advantaged students in control schools (with average poverty) decreased by about 0.32 *T*-score point per year (coefficient of -0.315). The positive estimated coefficient for immersion (0.222) suggests that math scores for advantaged students in immersion schools (with average poverty) decreased at a slightly slower rate compared to control students—about 0.10 *T*-score point per year. In contrast to reading, economically disadvantaged students at both immersion and control schools grew in mathematics achievement at a significantly slower rate than their more advantaged peers (about 0.29 *T*-score points less per year). Figure 6.2 shows the estimated mean TAKS mathematics growth trajectories for advantaged and disadvantaged students at immersion and control schools.

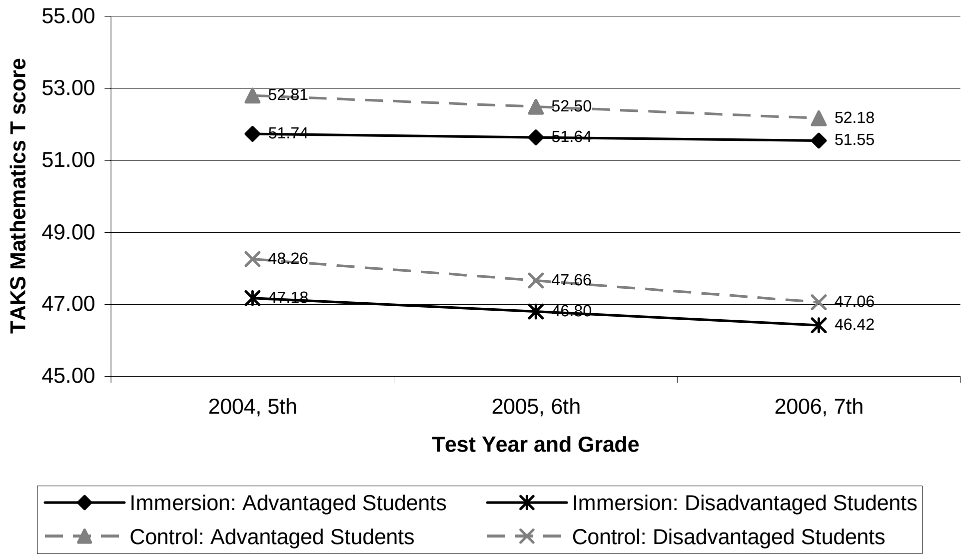

Figure 6.2. Estimated mean TAKS mathematics achievement growth trajectories for economically advantaged and disadvantaged student groups in immersion and control schools. Differences between immersion and control groups are statistically insignificant.

TAKS Writing

The effects of immersion on Cohort 1 students' writing scores were analyzed using a two-level HLM model (see Table 6.5). In the student-level model (level 1), students' 2006 writing *T* scores were regressed on 2003 writing scores (data from two years prior to the start of the technology immersion project), gender (1 if female, 0 if male), minority status (1 if Hispanic, 0 if not; 1 if African American, 0 if not), and economic status (1 if economically disadvantaged, 0 if not). A school-level model (level 2) answered the question of whether students in immersion schools had higher 2006 TAKS writing *T* scores than control-group students, after adjusting for initial achievement, student demographic characteristics, and school poverty. Immersion was an indicator variable with a value of 1 for an immersion school and a value of 0 for a control school. School poverty was a continuous variable indicating the percentage of economically disadvantaged students in a school (with a mean of 68.6%).

Table 6.5. Data for Cohort 1 (Seventh Graders): Effects of Immersion (Fixed) on TAKS Writing Achievement

Dependent variable and predictor	TAKS Writing *N* = 3,126	
	Gamma Coefficient	*t*-value
Intercept (TAKS *T* score)	51.116	78.70***
Immersion	-0.907	-1.47
School poverty	-0.011	-0.63
Female	2.237	6.29***
African American	-2.241	-4.05***
Hispanic	-1.162	-3.37**
Economic disadvantage	-1.712	-3.38**
Spring 2003 *T* score	0.617	30.28***

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

HLM analyses involved 1,445 immersion students and 1,681 control students (61.7% of students for immersion and 60.3% for control). Results for the analysis of the effects of immersion on Cohort 1 students' writing scores show that after controlling for students' 2003 TAKS writing *T* scores, student demographic characteristics (gender, ethnicity, economic status), and campus poverty level, there were no significant differences in the 2006 writing *T* scores for students in immersion and control schools. Contrary to expectations, the coefficient shows that the immersion effect on writing is negative (about -0.91 *T*-score points lower than the control group), although the difference between groups is statistically insignificant ($p = 0.149$).

Across both immersion and control schools, the demographic characteristics of students were strongly associated with TAKS writing achievement. Female students had significantly higher writing scores than males (about 2.24 *T*-score points); African American and Hispanic students had significantly lower writing scores than their non-minority group counterparts (-2.24 and -1.16 points, respectively); and economically disadvantaged students had significantly lower scores than their advantaged peers (-1.71 *T*-score points). Thus, students' background characteristics mattered more than whether they attended an immersion or control school.

Cohort 2 (Sixth Graders)

TAKS Reading and Mathematics

Immersion effects also were estimated for Cohort 2 students' TAKS reading and mathematics *T* scores (see Table 6.6). We analyzed the effects of immersion on sixth graders' reading and mathematics scores using separate two-level HLM models. In the student-level model (level 1), 2006 TAKS reading and mathematics *T* scores were regressed on 2005 reading and mathematics scores, gender (1 if female, 0 if male), minority status (1 if Hispanic, 0 if not; 1 if African American, 0 if not), and economic status (1 if economically disadvantaged, 0 if not). A school-level model (level 2) estimated whether immersion schools had higher TAKS achievement scores than control schools, after controlling for initial achievement, student demographic characteristics, and school poverty. The immersion variable identified the comparison groups (1 if immersion, 0 if a control school). School poverty was a continuous variable depicting the concentration of economically disadvantaged students in a school. Analyses involved approximately 1,800 immersion students and 2,000 control students, with similar proportions of comparison-group students included in analyses (about 67.8% for immersion and 70.9% for control). (See Appendix E for technical details).

Table 6.6. Data for Cohort 2 (Sixth Graders):
Effect of Immersion (Fixed) on TAKS Reading and Mathematics Achievement

Dependent variable and predictor	TAKS Reading $N = 3{,}789$		TAKS Mathematics $N = 3{,}838$	
	Gamma Coefficient	*t*-value	Gamma Coefficient	*t*-value
Intercept (TAKS *T* score)	48.828	108.41***	48.067	97.03***
Immersion	0.236	0.55	0.950	1.27
School poverty	-0.025	-1.91†	-0.020	-1.11
Female	1.518	7.11***	0.816	3.56**
African American	-0.957	-2.65**	-1.961	-3.80***
Hispanic	-0.869	-2.24*	-0.752	-2.52*
Economic disadvantage	-1.218	-3.43**	-1.027	-4.00***
2005 TAKS *T* score	0.648	24.03***	0.680	31.69***
Pretest x Immersion	0.011	0.34	0.050	1.97*

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

TAKS reading outcomes for sixth graders reported in Table 6.6 show that after controlling for students' prior reading achievement, demographic characteristics, and the level of school poverty, there were no significant differences in the 2006 TAKS reading *T* scores for students in immersion and control schools. The immersion effect on reading was positive (about 0.24 *T*-score points) but not statistically significant ($p = 0.584$). There was a slightly negative effect on TAKS reading achievement for sixth graders who attended schools with above average levels of school poverty (-0.03 *T*-score points). In contrast to school-level effects, students' individual characteristics were strong predictors of reading achievement. Female students had significantly higher TAKS reading *T* scores, whereas minority and economically disadvantaged students had significantly lower TAKS reading scores.

Results for sixth graders' TAKS mathematics scores showed that after controlling for students' prior math achievement, demographic characteristics, and school poverty, there was a significant immersion effect (0.050, $p = 0.055$) on students' 2006 TAKS mathematics *T* scores which acted through the 2005 TAKS math score. Figure 6.3 illustrates this effect for average immersion and control students. Other factors being equal, higher pretest math scores (2005 TAKS), predicted larger gaps in the posttest scores (2006 TAKS math) favoring immersion students. Thus, for mathematics, immersion had a stronger and significant effect for higher achieving students.

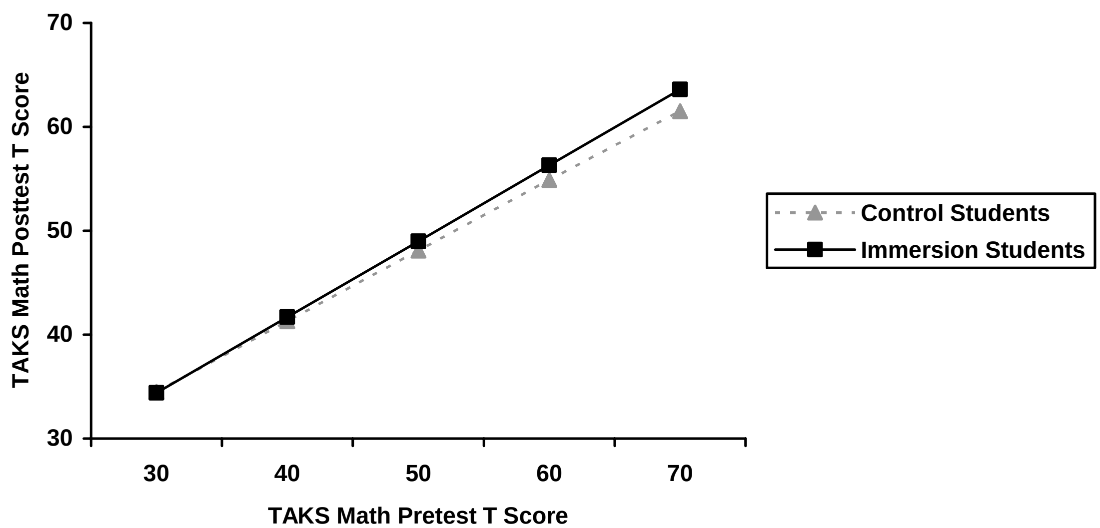

Figure 6.3. Significant immersion effect on TAKS mathematics achievement, which acts through the pretest score.

Conclusions

In the second project year, we examined the effects of immersion on Cohort 1 students (seventh graders who were continuously enrolled in schools for two years) and Cohort 2 students (sixth graders who were continuously enrolled for one school year). Key findings are the following.

- Results for Cohort 1, seventh graders showed no statistically significant effects of immersion on TAKS reading, mathematics, or writing achievement. Although no significant effects were evident, positive estimated mean growth trajectories for immersion students in TAKS reading and mathematics suggested that the achievement gap between immersion and control schools narrowed slightly over time. Economically disadvantaged students in immersion schools appeared to benefit the most through significantly improved reading achievement. Outcomes for TAKS writing favored students in control schools, although the difference was not statistically significant.

- Results for Cohort 2, sixth graders revealed no statistically significant effects of immersion on TAKS reading achievement. The immersion effect on reading was positive, but not large enough to differ significantly from control-group students. On the other hand, while there was no significant overall effect of immersion on TAKS mathematics achievement, immersion students who began with higher than average math pretest scores had significantly higher TAKS mathematics scores in 2006 than their control-group counterparts.

7. Conclusions and Implications

The evaluation of technology immersion (i.e., a laptop computer for every middle school student and teacher, wireless access throughout the campus, curricular and assessment resources, professional development and ongoing pedagogical support for curricular integration, and technical support for immersion) provides a scientific investigation of the effectiveness of technology immersion in increasing middle school students' achievement in core academic subjects. This research is important because it provides a large-scale, methodologically rigorous study of the impacts of ubiquitous technology at a time when the number of one-to-one technology initiatives is steadily increasing (Penuel, 2006; Gewertz, 2007). Furthermore, the conceptual framework guiding the research allows a comprehensive examination of technology-infused school and classroom environments that builds on and extends the existing knowledge base.

Given the limitations of the study's quasi-experimental design, we analyzed extensive baseline data to establish the comparability of treatment and control groups. In the project's second year, however, our research design was modified when two middle schools in one district (one immersion and one control) were excluded from analyses due to damage caused by Hurricane Rita on the Texas Gulf coast. Thus, second-year results are for the remaining 21 treatment and 21 control schools. A re-analysis of baseline data for the new sample revealed that school and student characteristics generally were unchanged and differences between groups remained statistically insignificant. Thus, the integrity of the study's research design appears sound. Even though comparison groups are reasonably well matched, immersion schools have somewhat larger proportions of economically disadvantaged students, so we have used statistical methods to adjust for remaining differences that arise from sampling variability. On the whole, researchers are confident that reported effects can be attributed to the treatment.

Our study, as designed, expanded to two student cohorts in the second year. Cohort 1 includes 5,538 seventh graders (2,627 immersion, 2,911 control) who completed their second project; Cohort 2 includes 5,507 sixth graders (2,685 immersion, 2,822 control) who finished their first year. Cohorts include predominantly minority (77%) and economically disadvantaged (74%) students. The middle schools are typically small (402 students, on average); however, enrollments vary widely (from 83 to 1,447 students). Although schools are highly concentrated in rural and very small Texas districts, about a third of districts and schools are in large cities or suburban locations.

Study Limitations

Generalization of findings to a broader population 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, on average, versus 667), and schools are located either in small or very small districts (64%) or large districts (36%). 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, student cohorts) verifies the robustness of findings.

Criteria for Concluding Effects

Until the 1990s, program effects were evaluated exclusively by testing the statistical significance of group differences. Since that time, scholars have recognized that statistical significance does not address (a) the importance of group differences, or (b) the replicability or truth of group differences (e.g., Cohen, 1994; Schmidt, 1996). Increasingly, researchers have attended as well to the effect sizes that quantify the group differences (cf. American Educational Research Association, 2006; Grissom & Kim, 2005; Thompson, 2006). Effect sizes quantify the degree to which group statistics, such as means, are unequal. Small effect sizes are noteworthy under certain conditions.

Small effect sizes are noteworthy when evidence suggests that effects are replicable. This occurs, for example, when effects are replicated (a) across subject matters (e.g., both reading and mathematics), or (b) across time (e.g., both Cohorts 1 and 2). The statistical significance tests reported in Chapter 6, and discussed here, do not test either of these forms of effect replicability, and so cannot address the result replicability question. Small effects are also more noteworthy when (a) the outcome variable is particularly resistant to intervention (Prentice & Miller, 1992), or (b) small effects generated over time cumulate into large effects (Abelson, 1985), or both. An example of effect cumulation in the context of the current project would be if learning or student behavior improved not only in the project intervention years, but continued subsequently in future grade levels. Of course, only continuing evaluation can document cumulative effects over time.

Summary of First- and Second-Year Findings

Our first-year report—*Evaluation of the Texas Technology Immersion Pilot: First-Year Results* (Shapley et al., 2006a)—revealed positive effects of technology immersion on *schools* (leadership, innovative culture, and parent and community support), *teachers* (technology proficiency and productivity, technology use and integration, and peer collaboration), and *students* (technology proficiency and use, small-group work, school satisfaction, and behavior). In most cases, the sizes of effects were of both statistical and practical importance. Findings for the second implementation year relative to these same variables are generally consistent with first-year results. Steadfast outcomes across two evaluation years and two student cohorts show that immersing a middle school in technology produces schools with stronger principal leadership for technology, greater teacher collaboration and collective support for technology innovation, and stronger parent and community support for technology. Additionally, teachers in immersion schools are more technically proficient and use technology more often for their own professional productivity, their students use technology more often in core-subject classrooms, and teachers adopt more integration-oriented and learner-centered ideologies. Students in immersion schools are more technically proficient, use technology more often for learning, interact more often with their peers in small-group activities, and have fewer disciplinary problems than control-group students.

Also consistent with first-year results, we found no significant effect of technology immersion in the second year on student self-directed learning, and we found a significantly negative immersion effect on school attendance. Moreover, the availability of technology across two years provided no significant increase in the intellectual challenge of immersion teachers' core-subject lessons.

First-year findings on academic achievement revealed no statistically significant immersion effects on Texas Assessment of Knowledge and Skills (TAKS) reading or mathematics scores for Cohort 1, sixth graders. Similarly, second-year results for Cohort 1 students (as seventh graders) showed no significant effects of immersion on TAKS reading, mathematics, or writing achievement. Likewise, achievement results for Cohort 2 students (sixth graders involved in the project for one year) revealed no significant effect of immersion on TAKS reading achievement. However, for TAKS mathematics, students in immersion schools who began the year with higher math pretest scores had significantly higher mathematics achievement than their control-group counterparts. The achievement gap favoring immersion students widened as pretest scores increased. Although TAKS score differences between immersion and control schools usually did not differ by statistically significant margins, second-year achievement trends, in contrast to first-year results, generally favored technology immersion schools.

The study's overall outcomes as described above reflect the effects of immersion for schools that typically achieved low project implementation levels. We reported in the first year that 20 of the 22 middle schools reached only *partial immersion* (2 on a 4-point implementation scale) rather than *substantial* (2 schools) or *full immersion* (no schools). Using somewhat different scoring criteria in the second year, we conclude that about a third of middle schools (6) achieved a *substantial* level of immersion, whereas the remaining two-thirds (15) reached *minimal* to *partial immersion* levels. Implementation evidence for this evaluation, consistent with other studies of whole-school reform, demonstrates that achieving quality implementation when the initiative involves fundamental school and classroom change is challenging (Borman, 2005; Vernez et al., 2006). Given existing contextual conditions, study limitations, and criteria for interpreting effects, major findings from the second year are described in the following section.

Major Second-Year Findings

Effects of Immersion on Teachers and Teaching

In the second project year we assessed the effects of immersion on teachers and teaching by examining teachers' rates of growth on mediating variables across three time points (fall 2004, spring 2005, and spring 2006). Analyses involved 802 teachers, including 364 in immersion schools and 438 in control schools. We observed classroom activities for a sample of core-subject teachers during the same time periods.

Immersion teachers grew in technology proficiency and in their use of technology for professional productivity at significantly faster rates than control teachers. Technology immersion accelerated teachers' growth in meeting the state's Technology Application Standards. In a self-assessment of their Technology Proficiency across three time points, immersion teachers considered themselves to be increasingly more technology literate than control teachers in areas involving technology operations (e.g., sending email and using software applications) and pedagogical skills (e.g., creating electronic presentations and creating lessons plans integrating technology). Estimated yearly growth trajectories for immersion and control teachers in schools with average levels of student poverty were 0.35 and 0.18 scale-score points per year, respectively, on a 7-point scale. Similarly, teachers in immersion schools used technology significantly more often for administrative and classroom management purposes. Estimated yearly growth trajectories for immersion and control teachers relative to their Professional Productivity were 0.26 and 0.09 scale-score points per year, respectively, on a 5-point scale. Teachers in immersion schools used technology more frequently for purposes such as communicating with students, posting information on a website, administering an online assessment, and accessing model lesson plans.

Teachers in immersion schools expressed stronger ideological associations across time with technology integration and learner-centered practices. Initially, immersion and control teachers expressed similar views on instructional practices involving technology; however, immersion teachers changed their instructional beliefs at a significantly more positive rate. For Technology Integration, the mean estimated growth trajectory for immersion teachers in schools with average poverty was 0.75 scale points per year compared to 0.27 for control teachers (on a 7-point scale). Thus, immersion teachers indicated that they 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 in learner-centered practices for immersion and control teachers in schools with average poverty were 0.48 and 0.20 scale-score points, respectively, on a 7-point scale.

Teachers at schools with higher concentrations of student poverty grew in technology proficiency and adopted new ideologies at slower rates. 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 widened. Similarly, teachers in schools with higher student poverty embraced technology integration and learner-centered practices at slower rates. Weaker supports for implementation at higher poverty immersion schools may at least partially explain teachers' slower progress. Core-subject teachers in these schools reported considerably fewer technology-related professional development hours than teachers in more advantaged schools (34 hours over two years, on average, vs. 52 hours). And, teachers' perception of the robustness of their professional development was positively correlated with the strength of their affiliation with new ideologies. The characteristics of teachers employed at schools also may contribute to differences. Higher poverty immersion schools had proportionately more male teachers. Accordingly, our analyses indicated that male teachers in middle schools were significantly less likely than their female counterparts to embrace innovative methods (i.e., technology integration and learner-centered instruction).

Given greater abundance of technology, teachers in immersion schools collaborated more often with their peers on technology-related issues than control teachers, and students used technology more often in immersion classrooms. With increased availability of technology, teachers at immersion schools compared to control had a significantly steeper growth trend for collaborative interactions with colleagues that supported improvements in instructional practices involving technology (e.g., developing lesson plans or exchanging information about students). Also, immersion teachers had a significantly steeper growth rate than control teachers for the frequency of their students' Classroom Activities involving technology (0.29 scale-score points per year vs. 0.04 points on a 5-point scale for teachers in schools with average poverty). Despite their positive growth trend, statistics indicated that by spring 2006, teachers in immersion schools had students use various technology resources infrequently (i.e., about once or twice a month). While the overall level of technology use was low, there was substantial teacher-to-teacher variation in students' classroom activities; mathematics teachers used technology considerably less often than English language arts, science, and social studies teachers.

Availability of technology resources had little, if any, effect on the intellectual challenge of immersion teachers' lessons. Technology immersion's theorized impact on student achievement hinges on technology's facilitation of more rigorous and authentic learning experiences. New resources are expected to promote students' high-level thinking, concept formation, inquiry and investigation, information utilization, exposure to places beyond the classroom, and real-world learning (Bransford et al., 2003; Goldman, Cole, & Syer, 1999; Johnston & Cooley, 2001; Sulla, 1999). These kinds of experiences are important because of established links between more challenging and authentic pedagogy and academic achievement (e.g., Newman & Associates, 1996; Newmann, Bryk, & Nagoaka, 2001). To gauge progress toward expected technology use, researchers rated the Intellectual Challenge of teachers' observed lessons (Newmann, Secada, & Wehlage, 1995).

Observations of core-subject teachers (English language arts, mathematics, science, and social studies) in fall 2004 and spring of 2005 and 2006 revealed no statistically significant differences between the intellectual demand of immersion and control teachers' lessons. Across all observed classrooms, lessons generally failed to intellectually challenge students, with ratings usually below 2 on the 5-point scale. Observational data for sixth-grade classrooms showed that lessons in immersion and control classrooms most often focused on student acquisition of facts, definitions, and algorithms (44% and 41% of observed time, respectively) and less often centered on writing communication related to the lesson (7% and 4% of time), constructing knowledge (10% and 13% of time), or engaging in disciplined inquiry (7% and 5% of time).

Effects of Immersion on Students and Learning

We examined the effects of immersion on students and their learning by measuring mediating variables across three time periods for Cohort 1 students (fall 2004, spring 2005, and spring 2006) and two periods for Cohort 1 students (fall 2005 and spring 2006). Analyses for Cohort 1 included approximately 3,100 students (1,454 immersion and 1,646 control); analyses for Cohort 2 included about 4,033 students (1,988 immersion and 2,045 control).

Technology immersion significantly increased students' technology proficiency and narrowed the gap between economically advantaged and disadvantaged students. Students in immersion schools reported significantly higher levels of technology proficiency than control students. Thus, immersion students made greater progress toward mastery of the Texas Technology Applications standards (e.g., sending an email attachment, creating a presentation, managing documents, using spreadsheets, and keeping track of websites). Estimated yearly growth in proficiency for economically advantaged and disadvantaged immersion students in Cohort 1 (0.41 and 0.47 scale-score points, respectively, on a 5-point scale) were nearly twice the rates for their control-group counterparts (0.21 and 0.27 scale-score points). Consequently, by the end of seventh grade, economically disadvantaged students in immersion schools surpassed advantaged control students in proficiency. Similarly, for Cohort 2, sixth graders, immersion had a significantly positive effect on students' technology proficiency (Effect size [ES] = 0.30). Immersion students' enhanced technical skills apparently allowed them to deal with technical troubles that typically accompany increased technology access and use because the extent of technical problems reported by immersion and control students did not differ by statistically significant margins.

Students in immersion schools used technology significantly more often in core-subject classrooms and interacted more frequently with their peers in small groups. Similar to their teachers' reports, Cohort 1 students at immersion schools had a significantly steeper growth trend for the frequency of Classroom Activities involving technology than control students. The yearly rates of change in class activities for economically advantaged and disadvantaged immersion students were 0.35 and 0.41 scale-score points, respectively (on a 5-point scale), compared to 0.03 and 0.09 points for comparable control-group students. Results for Cohort 2 students, similarly, revealed significant and practically important differences in Classroom Activities favoring immersion schools (ES = 0.83). Along with greater uses of classroom technology, students in immersion schools also had more frequent opportunities for collaborative and active learning. Growth rate coefficients for Cohort 1 showed that students in immersion schools had increasing opportunities across time for small-group work with their peers, whereas control students reported less frequent small-group activities as they advanced to seventh grade. The greater frequency of small-group work in immersion schools was replicated for Cohort 2 students (ES = 0.25).

Despite significant increases in classroom technology use in immersion schools, mean use statistics indicated that students used technology resources infrequently (about once or twice a month). Moreover, classroom observations showed that immersion students often used technology in rather conventional ways. Observed students most frequently used a word processor for writing, learned and practiced skills (typically multi-choice exercises or digitized worksheets), created or made presentations (using PowerPoint or Keynote), or conducted Internet searches for information on an assigned topic. Students had little chance to use technology for activities that supported deeper thinking and understanding, such as using technology to analyze or manage data, communicate with peers and experts, enhance understanding through simulations or modeling, or to visually represent or investigate concepts. Thus, changes in classroom activities and organizational structures in immersion classrooms did not necessarily alter the rigor or relevance of students' experiences with core-subject content.

Technology immersion had no significant effect on student self-directed learning. We theorized that the opportunities for independent and self-guided learning afforded through one-to-one technology would positively affect students' personal self-direction. Accordingly, student cohorts completed the *Style of Learning Inventory* as a measure of their self-direction. Findings in the second year replicated first-year results showing there was no significant immersion effect on students' self-direction. As both immersion and control students in Cohort 1 progressed from sixth to seventh grade, their responses to statements measuring self-direction revealed significantly negative growth trends. Thus, these students reported less self-regulated learning behaviors across time. Results for Cohort 2, sixth graders, likewise, revealed no significant immersion effect on student self-direction (ES = 0.03).

Outcomes for measures of student engagement varied. Students in immersion schools had significantly fewer disciplinary actions, similar levels of school satisfaction, and significantly lower school attendance rates than control-group students. A frequently cited benefit of one-to-one computing is increased student engagement as measured by indicators such as stronger commitment to academic work, increased attendance, and reduced discipline problems (e.g., MEPRI, 2003; Lowther, Ross, & Morrison, 2003; Rockman ET AL., 1998; 1999; Russell, Bebell, & Higgins, n.d.). Similarly, during site visits for this study, interviewed administrators, teachers, and students cited greater student interest and motivation for school and learning as positive immersion effects. For our quantitative measures, however, immersion students exhibited significantly stronger school engagement through more positive behavior, but they did not express greater satisfaction with school and they did not attend school more regularly than control students.

Behavior and discipline problems. Disciplinary Action Reports submitted to the TEA for each student during the 2005-06 school year, similar to the prior year, showed that immersion students had proportionately fewer behavioral and disciplinary problems than their counterparts in control schools. Cohort 1 immersion and control students had an average of 0.76 and 0.90 disciplinary actions, respectively (ES = 0.14); Cohort 2 immersion and control students had an average of 0.53 and 0.69 disciplinary actions, respectively (ES = 0.16). Even though effect sizes for the mean differences are small, having fewer disciplinary actions per student in middle schools may have important practical benefits in terms of day-to-day personnel time and effort required for addressing discipline problems that remove students from classrooms.

School satisfaction. Contrary to first-year results showing higher levels of school satisfaction for Cohort 1 students, survey outcomes for the second year showed no significant difference in school satisfaction between students in immersion and control schools. Students across both comparison groups and cohorts expressed correspondingly modest levels of satisfaction with the kinds of work they do in classes and with the relevance of their schoolwork. The lower satisfaction level for Cohort 1, seventh graders in immersion schools may reflect a drop in the initial euphoria that students experienced upon receiving their laptops in the first year. Additionally, as schools experienced disciplinary and safety problems involving students' use of email and the Internet, they restricted students' Internet access and use of laptops for communication purposes in the second year. Lower school satisfaction may reflect immersion students' disenchantment with stricter laptop policies.

School attendance. Unexpectedly, students in immersion schools had significantly lower school attendance rates than control-group students. For Cohort 1, average school attendance rates decreased as students advanced from fifth to seventh grade. The yearly estimated decline in attendance for economically advantaged immersion students (-0.57 percentage points) was greater than the annual change for similar control students (-0.36 points). Thus, at the end of seventh grade, advantaged students in immersion schools had an estimated average attendance rate of 95.9% compared to 96.4% for their control-group counterparts. Attendance rates for economically disadvantaged students decreased at an even faster pace (coefficients of -0.73 and -0.51 percentage points for immersion and control students, respectively). Results for Cohort 2 students, similarly, showed small but statistically significant differences in attendance rates favoring students in control schools (ES = 0.07). Researchers currently have no evidence that explains why immersion students have lower attendance rates; however, we will continue the investigation of attendance trends in the third evaluation year.

Effects of Immersion on Academic Achievement

The ultimate goal of technology immersion is increasing middle school students' achievement in core academic subjects as measured by state assessments. For analyses reported below, students' TAKS scale scores were standardized and then normalized as T scores with a mean of 50 and a standard deviation of 10. Analyses for Cohort 1 included about 3,450 students (1,590 immersion and 1,860 control); Cohort 2 included about 3,838 students (1,805 immersion and 2,033 control).

Technology immersion had no statistically significant effect on Cohort 1, seventh graders' achievement in reading, mathematics, or writing. For Cohort 1 students, we used three-level hierarchical linear modeling (HLM) to estimate mean rates of change in TAKS reading and mathematics scores and a two-level HLM model to estimate the effects of immersion on writing scores.

- **Reading.** Controlling for student and school poverty, there was no significant effect of immersion on students' growth rate for TAKS reading. Advantaged students in control schools (with average poverty) began with a mean TAKS reading *T* score of 53.83, and their achievement decreased by about 0.55 *T*-score point per year (coefficient of -0.547). Estimated reading scores for advantaged students in immersion schools (with average poverty) decreased at a slightly slower yearly rate than control students (positive coefficient of 0.257). Economically disadvantaged students in both immersion and control schools grew in reading achievement at a significantly faster rate than their more advantaged peers (0.461 *T*-score points per year). Combined with the immersion result, this yielded a positive boost in reading achievement for economically disadvantaged immersion students.
- **Mathematics.** After controls for student and school poverty, there was no significant effect of immersion on students' growth rate for TAKS mathematics. Advantaged students in control schools (with average poverty) had an estimated initial mean *T* score of 52.81, and their math scores decreased by about 0.32 *T*-score points per year (coefficient of -0.315). Estimated math scores for advantaged immersion students decreased at a slightly slower rate (positive coefficient of 0.222). In contrast to reading, economically disadvantaged students at both immersion and control schools grew in mathematics achievement at a significantly slower rate than their more advantaged peers (-0.285 *T*-score points per year).
- **Writing.** Cohort 1 students completed TAKS writing assessments in 2003 (4th grade) and again in 2006 (7th grade). After adjusting for initial achievement, student demographic characteristics, and school poverty, there was no statistically significant difference in the 2006 writing scores for students in immersion and control schools. The immersion effect was

negative but not by a statistically significant margin (about 0.91 *T*-score points lower than the control group).

Technology immersion had no statistically significant effect on Cohort 2, sixth graders' reading achievement; however, immersion had a significantly positive effect on mathematics scores for higher achieving students. We analyzed the effects of immersion on Cohort 2 students' TAKS reading and mathematics scores using two-level HLM models. Cohort 2 students completed TAKS assessments in 2005 (5th grade) and again in 2006 (6th grade).

- **Reading.** Controlling for students' prior achievement, demographic characteristics, and school poverty, there was no significant difference in the 2006 TAKS reading scores for students in immersion and control schools. The immersion effect on reading was positive (about 0.24 *T*-score points) but not by a statistically significant margin.
- **Mathematics.** After controls for students' prior achievement, demographic characteristics, and school poverty, there was no overall significant difference between immersion and control students' TAKS mathematics scores. The overall immersion coefficient was positive (0.95 *T*-score points) but not by a statistically significant margin. However, there was a statistically significant immersion effect on mathematics achievement that acted through students' pretest scores. Other factors being equal, having higher pretest scores predicted larger gaps in 2006 math scores favoring immersion students. Thus, immersion had a significantly positive effect on mathematics achievement for higher achieving sixth graders.

Second-year achievement trends generally favored technology immersion schools. Although TAKS scores for students attending immersion and control schools usually did not differ in the second year by statistically significant margins, noteworthy achievement trends emerged. In the first project year, TAKS reading and mathematics achievement trends favored control schools. Conversely, in the second year, immersion schools had more positive achievement trends than control schools across *both* student cohorts and for *both* reading and mathematics. In particular, Cohort 1, seventh graders had more positive reading and math growth trajectories than control-group students. Similarly, reading and mathematics outcomes for Cohort 2, sixth graders showed positive achievement tendencies favoring immersion students.

Outcomes for TAKS writing favored students in control schools. The assessment of writing, however, differed from other subject areas in several ways. First, the span of time between the pretest (2003) and posttest (2006) was wider. The testing mode for writing also may be a confounding factor. The TAKS assessment was administered in traditional paper-and-pencil format, and some research shows that paper-and-pencil assessments underestimate the writing achievement of students who regularly use word processors for writing (e.g., Russell & Haney, 1997). Other research, however, has found no testing mode differences in aggregate writing performance, although outcomes for individuals may vary (e.g., Sandene et al., 2005).

Second-year findings provide formative evaluation outcomes. The evaluation of technology immersion is a four-year, longitudinal study, and findings from the second year reflect preliminary outcomes. In designing the study, we thought that some effects might emerge during the early implementation years, but we also believed that changes in longer term outcomes, such as student achievement, might require at least three years to surface (i.e., time for Cohort 1 students to progress from sixth to eighth grade). Specifically, we have noted that low project implementation at schools during the first two years may diminish immersion's potential impact on achievement. Major concerns include students' inconsistent use of laptops across classrooms and subject areas, uneven provision of professional development supporting the design of effective technology-infused lessons, and variability in students' access to laptops both within and outside of school. Additionally, outcomes so far have focused mainly on TAKS reading and mathematics. In the third year, Cohort 1 eighth graders will complete TAKS social studies and science assessments, so outcomes will be available for each of the core-subject areas.

Moreover, although student achievement outcomes as measured by TAKS scores are extremely important, there are other outcomes for immersion students that may contribute to their long-term success. Certainly, technology immersion has narrowed the technology equity gap for economically disadvantaged students. Many students who previously had no technology in their homes are becoming computer literate through their experiences with laptops. Administrators, teachers, and students alike at immersion schools believe that these middle school students are better prepared for future educational and workforce requirements and for 21st Century expectations, such as communication skills, and information and media literacy.

In the section to follow, we describe how the varying levels of implementation may have contributed to second-year results.

Nature of Second-Year Implementation

Most of the middle schools struggled in the second year to implement the prescribed components of technology immersion. Full implementation of the 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. The Implementation Index, a composite campus *z* score that measures the overall presence of immersion components, showed that about a third of middle schools (6 of 21) attained a stronger presence of the technology immersion components that more nearly approximated expected standards, whereas two-thirds had lower implementation levels. Overall, mean immersion standard scores (ranging from 2.48 to 3.06) showed that supports for technology immersion from school principals, teachers, parents and community members, technical staff, and professional development providers generally failed to meet full implementation standards (3.50 to 4.00).

Given generally low-to-moderate supports for immersion, the overall extent of Classroom Immersion (2.48) and the robustness of Student Access and Use (2.17) were below expectations. Overall, immersion teachers' behaviors in the second project year were consistent with other research on teachers' adoption of technology-based practices. Teachers tended to use new resources to support their existing teaching practices and they used technology for student learning to a limited extent (Sanholdtz, Ringstaff, & Dwyer, 1997; Windschitl & Sabl, 2002). Although many teachers have made significant strides in using laptops and digital resources in their classrooms over two project years, most teachers still need time and continuing support for incremental classroom change.

The strength of professional development and other supports were associated with higher levels of classroom and student immersion. Variability in the extent and quality of each school's professional development component was a major obstacle to teachers' growth in creating technology-immersed classrooms. Even though the immersion model required that a quarter of grant funds be expended for professional development that advanced technology integration into teaching and learning, the professional development design rested largely with individual districts and campuses and their selected technology vendors (mainly Apple or Dell). An analysis of associations between the various immersion support components and classroom practices indicated that strength of campus professional development was significantly correlated with teachers' reported levels of classroom immersion. Robust professional development was strongly associated with teachers' ideological beliefs about the adoption of technology integration and learner-centered practices.

Leadership for immersion also emerged as an important factor in advancing school change. Teachers' perception of leadership strength was significantly associated with their commitment to technology innovation, views on parent and community support, perception of professional development quality, and opinions about technical support adequacy. Thus, principals appeared to influence teachers' attitudes toward technology through their provision of supports for changed practice. Similarly, students' access to and use of technology for learning was significantly related to their teachers' greater involvement in professional development as well as the strength of the school's supports for immersion.

A continuing challenge in the second year was the consistent provision of laptops for students both within and outside of school. Student laptop access varied widely both across and within schools. The average number of laptop access days reported by students ranged from 42 to 178 days, with about a tenth of campuses having full access (the targeted 170 to 180 days per student). Although students in a fully immersed school should have access to their wireless laptops and resources nearly the entire school year, we found that student access was limited in the second year by a number of factors, such as disciplinary infractions, technical issues, time for repairs, and in a few cases, parent resistance. Additionally, some immersion schools allowed students to have unlimited access to laptops outside of the school day, while others restricted students' out-of-school access to a series of days or to laptop check-outs for teacher-assigned schoolwork. Overall, laptops' potential influence on learning varied across students and schools. The school's emphasis on professional development and the level of teacher and parent/community support for immersion were positively associated with students' laptop use for learning at home (i.e., for homework in core subjects or learning games).

Schools with a greater proportion of economically disadvantaged students had lower levels of implementation. Schools with more economically disadvantaged student populations had significantly lower levels of implementation. Accordingly, teachers at these schools grew in proficiency and created immersed classrooms at significantly slower rates than teachers in more advantaged schools. Evidence suggests that schools serving mainly disadvantaged and often low-performing student populations face special challenges in implementing technology immersion, a whole-school initiative that involves profound school and classroom change. Such schools may need additional time to prepare for immersion and additional supports to devise and enact implementation plans that meet the specific needs of teachers, students, and parents at these schools.

Researchers have conducted additional analyses to explore associations between the level of implementation and student academic achievement. However, these analyses are complex due to varying student attrition rates across immersion schools and have produced inconsistent results. We will continue in the third evaluation year to explore these associations.

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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 framework is provided in sections to follow for school, teacher, and student variables. 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.

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.

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 (see Chapter 1). 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).

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

Survey Items and Scale Reliabilities

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

Scale/ Item	Cronbach's Alpha			
	Fall 2004	Spring 2005	Fall 2005	Spring 2006
Leadership and System Support	0.91	0.92	0.92	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	0.62	0.76
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	0.68	0.66
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	0.81	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	0.84	0.85
Parents support our school's emphasis on technology.				
The surrounding community actively supports our instructional efforts with technology.				

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

Scale/ Item	Cronbach's Alpha			
	Fall 2004	Spring 2005	Fall 2005	Spring 2006
Technology Proficiency: I am confident that I can…	0.97	0.97	0.97	0.97
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	0.93	0.94
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, graphics).				
Post homework, class requirements, or project information on a website.				
Administer a formative assessment using Texas Mathematics Diagnostic System.				

Scale/ Item	Cronbach's Alpha			
	Fall 2004	Spring 2005	Fall 2005	Spring 2006
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	0.99	0.98
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).				
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	0.88	0.93
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	0.93	0.95
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.				

Scale/ Item	Cronbach's Alpha			
	Fall 2004	Spring 2005	Fall 2005	Spring 2006
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	0.79	0.81
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	0.81	0.77
I do not find computers to be a necessary part of classroom instruction.				
Using the classroom computer(s) is not a priority for me this school year.				
I do not find the use of computers to be practical for my students.				

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

Scale/ Item	Cronbach's Alpha			
	Fall 2004	Spring 2005	Fall 2005	Spring 2006
Technology Proficiency: How far along are you in learning to...	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	0.93	0.91
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	0.86	0.84
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.				

Scale/ Item	Cronbach's Alpha			
	Fall 2004	Spring 2005	Fall 2005	Spring 2006
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	0.81	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	0.78	0.80
I am satisfied with the work that I do in my classes.				
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	0.88	0.89
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				

Scale/ Item	Cronbach's Alpha			
	Fall 2004	Spring 2005	Fall 2005	Spring 2006
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 sohoolwork.				
If an assignment isn't going to count toward my grade, I don't need to know how well I did on it.				
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 C

Measuring Implementation Fidelity

In the second year, 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 C.1 shows the scoring rubrics for immersion indicators, and Table C.2 describes the data sources used to generate scores.

Supports for Implementation

Leadership

Our measure of principal leadership comes from teacher survey items (12) that yield a Leadership scale score. Items assess the extent to which the principal involves staff in decisions, sets clear expectations for technology use, encourages and participates in professional development, has a well-developed technology plan, promotes teacher innovation, and provides 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 the principal 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 two-year technology immersion implementation period. 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 C.1. Scoring Rubrics for Measuring the Implementation Fidelity of Technology Immersion

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 2.18 to 3.48 M=2.90 SD=0.33	Teachers *disagree or strongly disagree* that the principal establishes clear vision and expectations, encourages integration, provides supports, and involves staff in decisions.	Teachers are *unsure* that the principal establishes clear vision and expectations, encourages integration, provides supports, and involves staff in decisions.	Teachers *agree* that the principal establishes clear vision and expectations, encourages integration, provides supports, and involves staff in decisions.	Teachers *agree or strongly agree* that the principal establishes clear vision and expectations, encourages integration, provides supports, and involves staff in decisions.	Campus *z* Scores -2.20 to 1.78
Teacher Support (Innovative Culture)					
Campus Scores 2.33 to 3.41 M=3.06 SD=0.28	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 -2.65 to 1.25
Parent and Community Support					
Campus Scores 1.58 to 3.28 M=2.63 SD=0.40	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 -2.59 to 1.60
Technical Support					
Campus Scores 2.32 to 3.50 M=2.73 SD=0.29	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 -1.42 to 2.66

Table C.1. Scoring Rubrics for Measuring the Implementation Fidelity of Technology Immersion (*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 0.50 (10hrs) to 4.0 (112hrs) M=2.30 (47.8hrs) SD=1.16	Core-subject teachers, on average, participated in 35 or less hours of PD over the past two school years.	Core-subject teachers, on average, participated in 36 to 59 hours of PD over the past two school years.	Core-subject teachers, on average, participated in 60 to 74 hours of PD over the past two school years.	Core-subject teachers, on average, participated in 75 or more hours of PD over the past two school years.	-1.44 to 2.09
Classroom Support Campus Scores 1.42 to 2.83 M=2.13 SD=0.35	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 3.71 M=2.97 SD=0.38	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 1.87 to 3.53 M=2.54 SD=0.39	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 0.93 (147 days) to 3.94 (180 days) M=2.69 (172.2 days) SD=0.71	Students' laptop access days vary to an *extremely large extent* at a campus, with laptops available from about 42 to 169 days per student.	Students' laptop access days vary to a *large extent* at a campus, with laptops available from about 100 to 176 days per student.	Students' laptop access days vary do a *moderate* extent at a campus, with laptops available from about 140 to 178 days per student.	Students' laptop access days vary to a *small extent* at a campus, with laptops available from about 170 to 180 days per student.	-2.55 to 1.78
Core-Content Learning Campus Scores 1.18 to 2.71 M=2.07 SD=0.46	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 0.42 to 2.66 M=1.75 SD=0.57	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 C.1. Scoring Rubrics for Measuring the Implementation Fidelity of Technology Immersion (*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 -1.74 to 1.68
Technology Integration Campus Scores 1.75 to 3.09 M=2.48 SD=0.38	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 1.63 to 3.07 M=2.45 SD=0.41	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 1.83 to 2.91 M=2.33 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 1.13 to 3.37 M=2.38 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 2.44 to 3.16 M=2.73 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 -1.70 to 1.91

Table C.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 C.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 two school years (i.e., since August 1, 2004).	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 C.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 C.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 D

Effects of Technology Immersion on Schools

On one part of surveys, teachers responded to items pertaining to their perceptions of school-level supports for technology. Teachers were asked to rate the strength of their agreement with statements on a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Four distinct organizational factors emerged from a factor analysis: Leadership (12 items), Innovative Culture (4 items), Parent and Community Support (2 items), and Technical Support (5 items). Cronbach's alpha reliability coefficients for the scale scores ranged from acceptable (0.66) to excellent (0.94).

In addition to using school-level supports for technology to measure the implementation levels of the technology immersion model, we also have used school-level scores to compare treatment and control teachers prior to technology immersion and after the first and second implementation years. We analyzed the effects of immersion on teachers' perceptions of school-level indicators of technology support using separate *t* tests to estimate differences between immersion and control teachers. We also calculated effect sizes (Cohen's *d*) as a way to show the relative strength of differences. Effect size (ES) are expressed as standard deviations. For example, an effect size of 1.00 indicates teachers' average score at an immersion school is one full standard deviation above the scores for control group teachers. Effect sizes can be interpreted generally as large (greater than 0.50), moderate (0.50-0.30), small (0.30-0.10), or trivial (less than 0.10).

Effects on School-Level Technology Supports

In Chapter 3, we reported that the strength of school-level supports for technology immersion varied across the 21 treatment campuses. Collectively, however, teachers at immersion schools perceived significantly stronger technology supports than teachers at control campuses. Data from analyses of school variables, summarized in Table D.1, show that at the end of both the first implementation year (spring 2005) and second implementation year (spring 2006), teachers at immersion schools reported significantly higher scale scores than control teachers on item measuring their levels of agreement with the provision of four school-level supports for technology:

- Leadership (Effect sizes = 0.44 and 0.33, respectively, in spring 2005 and 2006),
- Teacher Support (Effect sizes = 0.44 and 0.40),
- Parent and Community Support (Effect sizes = 0.51 and 0.24), and
- Technical Support (Effect sizes = 0.33 and 0.20).

Teachers' responses across time help to explain the effects of immersion on their perceptions of technology-related supports.

Leadership

The scale score for Leadership indicates the extent to which teachers believe their principal establishes a clear vision and expectations for technology, encourages classroom integration, provides needed supports, and involves staff in decision making. Results show that in the fall of 2004, teachers at immersion schools reported significantly higher Leadership scores for their principals than control teachers (*M* = 3.71 vs. 3.60, ES = 0.17). This may have reflected teachers' initial optimism about their principals' proactive efforts to secure Technology Immersion Pilot (TIP) grants. In the spring of 2005, after one year of project implementation, immersion teachers reported even stronger Leadership (ES =

0.44), and their higher estimations of principal leadership, compared to control teachers, was sustained at the end of the second year (ES = 0.35). Teachers at immersion schools tended to *agree* that their principals provided technology-related support.

Table D.1. Comparison Group Differences for School-Level Technology Support Variables

School Variables	Immersion *N* =21		Control *N*=21		*t*-value	*p*	Effect Size
	Mean	*SD*	Mean	*SD*			
Leadership							
Fall 2004	3.71	0.61	3.60	0.67	2.88	0.004*	0.17
Spring 2005	3.89	0.61	3.60	0.68	6.91	0.000*	0.44
Spring 2006	3.89	0.65	3.64	0.75	5.78	0.000*	0.35
Teacher Support (for innovation)							
Fall 2004	3.72	0.66	3.70	0.67	0.42	0.673	0.03
Spring 2005	4.00	0.60	3.73	0.65	6.91	0.000*	0.44
Spring 2006	4.06	0.62	3.80	0.68	6.62	0.000*	0.40
Parent and Community Support							
Fall 2004	3.44	0.78	3.39	0.74	1.16	0.248	0.07
Spring 2005	3.75	0.71	3.38	0.74	8.16	0.000*	0.51
Spring 2006	3.64	0.82	3.44	0.85	3.93	0.000*	0.24
Technical Support							
Fall 2004	3.29	0.74	3.30	0.76	-0.33	0.742	-0.02
Spring 2005	3.60	0.69	3.36	0.76	5.19	0.000*	0.33
Spring 2006	3.63	0.67	3.49	0.70	3.35	0.001*	0.20

Notes. Scale scores range from 1.00 to 5.00. Fall 2004: *N*=521 to 530 immersion teachers, *N*=604 to 609 control teachers; spring 2005: *N*=465 to 478 immersion teachers and *N*=524 to 544 control teachers; spring 2006: *N*=505 to 517 immersion teachers and *N*=576 to 586 control teachers. *Statistically significant difference. Effect size is Cohen's *d*. The effect size is interpreted as follows: a value greater than 0.5 is large, 0.5-0.3 is moderate, 0.3-0.1 is small, and anything smaller than 0.1 is trivial.

Innovative Culture

The scale score for Innovative Culture reflects the extent to which teachers at a school share an understanding about technology use, continually learn, are unafraid of new technologies, and are generally supportive of technology integration efforts. In fall 2004, there were no significant differences between groups in teachers' opinions. However, at the end of each implementation year, teachers at immersion schools were significantly more likely than control teachers to view their school culture as innovative (ES = 0.44 and 0.40, respectively, in 2005 and 2006). Immersion teachers generally *agreed* with statements reflecting an Innovative Culture for technology.

Parent and Community Support

Scores for Parent and Community Support show the extent to which teachers believe that parents and the surrounding community support the school's efforts with technology. There were no significant differences between immersion and control teachers' views on the degree of support from parents and community members in fall of 2004, but at the end of the first implementation year (spring 2005), teachers at immersion schools reported a significantly stronger level of support than control teachers (ES = 0.50). After the second implementation year (spring 2006), immersion teachers' positive perceptions of Parent and Community Support had waned, but their estimations of support still significantly exceeded control teachers' views (ES = 0.24). Even so, immersion teachers expressed a degree of *uncertainty* about Parent and Community Support for immersion at the end of the second year.

Technical Support

The Technical Support scale indicates the extent to which teachers believe technical problems with computers, Internet access, repairs, and material availability pose barriers to technology integration. In fall 2004, there were no significant differences between immersion and control teachers' perceived support. However, with the infusion of technology resources and additional support staff through Technology Immersion Pilot (TIP) grants, immersion teachers reported significantly higher levels of Technical Support than control teachers at the end of the first and second implementation years (ES's = 0.33 and 0.22, respectively, in 2005 and 2006).

In sum, teachers at immersion schools compared to control perceived stronger school-level organizational supports for technology from principals, parents and the community, and technical staff. And, as a whole, they also expressed greater affinity for innovative technology practices. Notably, however, teachers at control schools reported increasingly higher levels of agreement for each of the organizational support indicators across survey years. An additional, longitudinal analysis for teachers who were in the immersion project from fall 2004 through spring 2006 showed significant increases in immersion teachers' reported agreement with the extent of support for each of the four indicators (similar to the cross-sectional findings). Longitudinal results for control teachers who were at the schools during the same time period revealed statistically significant increases for two school-level indicators (Technical Support and Innovative Culture).

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	2,406	1.00	0.82
Technology Proficiency	2,311	4.65	1.43
Professional Productivity	2,294	3.15	0.72
Technology Integration	2,192	3.49	1.53
Learner-Centered Instruction	2,255	3.92	1.34
Resistance to Integration	2,275	2.31	1.30
Student Classroom Activities	2,283	2.10	0.79
Collaboration	2,291	2.49	0.78
School-Level Descriptive Statistics (Level 3)			
Immersion status (1 = yes, 0 = no)	42	0.50	0.51
School percent economically disadvantaged	42	68.58	17.56

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)	4.476	0.086	51.88***
	Immersion dummy	-0.151	0.143	-1.06
	School poverty	-0.001	0.004	-0.15
	Growth rate	0.176	0.033	5.26***
	Immersion dummy	0.178	0.044	4.02***
	School poverty	-0.004	0.001	-2.66*
Professional Productivity				
	Initial status (fall 2004)	2.984	0.056	53.30***
	Immersion dummy	-0.057	0.080	-0.72
	School poverty	0.002	0.002	0.68
	Growth rate	0.089	0.020	4.49***
	Immersion dummy	0.167	0.028	5.90***
	School poverty	-0.001	0.001	-1.11
Technology Integration				
	Initial status (fall 2004)	2.836	0.068	41.80***
	Immersion dummy[a]	0.234	0.116	2.02*
	School poverty	0.009	0.003	2.83**
	Growth rate	0.265	0.044	6.08***
	Immersion dummy[a]	0.528	0.074	7.10***
	School poverty	-0.004	0.002	-1.74†

Continued

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

Learner-Centered Instruction				
	Initial status (fall 2004)	3.561	0.051	69.45***
	Immersion dummy	0.034	0.090	0.37
	School poverty	0.005	0.002	2.30*
	Growth rate	0.200	0.037	5.39***
	Immersion dummy	0.278	0.066	4.20***
	School poverty	-0.002	0.002	-1.18
Resistance to Integration				
	Initial status (fall 2004)	2.359	0.054	43.59***
	Immersion dummy[b]	-0.240	0.075	-3.20**
	School poverty	0.001	0.002	0.76
	Growth rate	0.083	0.038	2.20*
	Immersion dummy[b]	-0.092	0.055	-1.66
	School poverty	0.000	0.002	-0.08
Student Classroom Activities				
	Initial status (fall 2004)	1.864	0.045	41.03***
	Immersion dummy	0.052	0.065	0.80
	School poverty	0.004	0.002	2.07*
	Growth rate	0.043	0.021	2.01*
	Immersion dummy	0.285	0.036	8.03***
	School poverty	0.000	0.001	0.13
Collaboration				
	Initial status (fall 2004)	2.255	0.053	42.24***
	Immersion dummy[c]	0.138	0.080	1.73†
	School poverty	0.003	0.002	1.28
	Growth rate	0.055	0.022	2.47*
	Immersion dummy[c]	0.154	0.042	3.72**
	School poverty	0.001	0.001	1.14

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

[a]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 difference between the original and adjusted immersion coefficients was not significant (the difference divided by the standard error of the difference = 0.43).

[b]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 difference between the original and adjusted immersion coefficients was not significant (the difference divided by the standard error of the difference = 0.42).

[c]Immerssion teachers had significantly higher initial levels of collaboration. A latent variable regression, controlling for the effect of this initial difference on the growth rate, indicated that the difference between the original and adjusted immersion coefficients was not significant (the difference divided by the standard error of the difference = 1.54).

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	0.2926			
Level-2 individual initial status	1.8021	760	6219.50	0.000
Level-2 individual growth rate	0.0723	760	1126.72	0.000
Level-2 school initial status	0.0720	39	75.76	0.001
Level-2 school growth rate	0.0064	39	70.54	0.002
Professional Productivity				
Level-1 temporal variation	0.1451			
Level-2 individual initial status	0.3213	755	2658.38	0.000
Level-2 individual growth rate	0.0113	755	864.43	0.004
Level-2 school initial status	0.0332	39	102.17	0.000
Level-2 school growth rate	0.0028	39	74.06	0.001
Technology Integration				
Level-1 temporal variation	0.6095			
Level-2 individual initial status	1.3284	741	2465.51	0.000
Level-2 individual growth rate	0.0349	741	816.25	0.028
Level-2 school initial status	0.0222	39	60.30	0.016
Level-2 school growth rate	0.0302	39	104.73	0.000
Learner-Centered Instruction				
Level-1 temporal variation	0.6904			
Level-2 individual initial status	1.0164	751	1989.28	0.000
Level-2 individual growth rate	0.0406	751	835.96	0.016
Level-2 school initial status	0.0054	39	53.82	0.057
Level-2 school growth rate	0.0171	39	73.77	0.001
Resistance to Integration				
Level-1 temporal variation	0.7286			
Level-2 individual initial status	0.7968	749	1711.66	0.000
Level-2 individual growth rate	0.0801	749	919.71	0.000
Level-2 school initial status	0.0075	39	44.58	0.248
Level-2 school growth rate	0.0064	39	54.49	0.051
Student Classroom Activities				
Level-1 temporal variation	0.1920			
Level-2 individual initial status	0.3025	753	2101.71	0.000
Level-2 individual growth rate	0.0134	753	845.06	0.011
Level-2 school initial status	0.0136	39	69.90	0.002
Level-2 school growth rate	0.0051	39	81.68	0.000
Collaboration				
Level-1 temporal variation	0.2287			
Level-2 individual initial status	0.2626	753	1743.19	0.000
Level-2 individual growth rate	0.0178	753	867.25	0.003
Level-2 school initial status	0.0334	39	100.76	0.000
Level-2 school growth rate	0.0081	39	85.22	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	2,406	1.00	0.82
Technology Proficiency	2,311	4.65	1.43
Professional Productivity	2,294	3.15	0.72
Technology Integration	2,192	3.49	1.53
Learner-Centered Instruction	2,255	3.92	1.34
Resistance to Integration	2,275	2.31	1.30
Student Classroom Activities	2,283	2.10	0.79
Collaboration	2,291	2.49	0.78
Teacher-Level Descriptive Statistics (Level 2)			
Male	802	0.30	0.46
Hispanic	802	0.39	0.49
African American	802	0.04	0.20
Experience	802	12.76	9.29
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)	5.281	0.089	59.19***
	Immersion dummy	-0.112	0.112	-1.00
	Male	-0.125	0.130	-0.96
	Hispanic	-0.249	0.097	-2.57)
	African American	0.200	0.132	1.51
	Experience	-0.055	0.006	-9.81***
	Growth rate	0.098	0.035	2.76**
	Immersion dummy	0.181	0.048	3.75**
	Male	-0.054	0.041	-1.31
	Hispanic	0.010	0.052	0.19
	African American	0.033	0.065	0.50
	Experience	0.006	0.002	2.77**
Professional Productivity				
	Initial status (fall 2004)	3.277	0.080	40.77***
	Immersion dummy	-0.047	0.074	-0.63
	Male	-0.167	0.064	-2.60*
	Hispanic	0.044	0.053	0.84
	African American	0.113	0.087	1.29
	Experience	-0.020	0.004	-4.68***
	Growth rate	0.044	0.026	1.73#
	Immersion dummy	0.167	0.028	6.04***
	Male	-0.012	0.025	-0.49
	Hispanic	0.004	0.024	0.19
	African American	0.046	0.066	0.70
	Experience	0.003	0.001	2.30*

(*Continued*)

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

Technology Integration				
	Initial status (fall 2004)	3.069	0.112	27.35***
	Immersion dummy	0.235	0.125	1.89
	Male	-0.140	0.095	-1.47
	Hispanic	0.335	0.111	3.02**
	African American	0.556	0.178	3.12**
	Experience	-0.023	0.006	-3.88***
	Growth rate	0.277	0.056	4.94***
	Immersion dummy	0.535	0.077	6.93***
	Male	-0.089	0.043	-2.07*
	Hispanic	-0.118	0.065	-1.82
	African American	0.093	0.101	0.92
	Experience	0.003	0.002	1.15
Learner-Centered Instruction				
	Initial status (fall 2004)	3.498	0.062	56.83***
	Immersion dummy	0.054	0.093	0.58
	Male	-0.144	0.089	-1.62
	Hispanic	0.256	0.103	2.49*
	African American	0.642	0.160	4.01***
	Experience	-0.025	0.005	-4.94***
	Growth rate	0.237	0.038	6.28***
	Immersion dummy	0.284	0.067	4.25***
	Male	-0.112	0.057	-1.95*
	Hispanic	-0.043	0.058	-0.74
	African American	0.082	0.090	0.92
	Experience	0.003	0.003	1.09
Resistance to Integration				
	Initial status (fall 2004)	2.080	0.087	23.84***
	Immersion dummy[a]	-0.263	0.070	-3.76***
	Male	0.416	0.097	4.29***
	Hispanic	-0.228	0.065	-3.50**
	African American	-0.599	0.094	-6.36***
	Experience	0.023	0.005	4.98***
	Growth rate	0.125	0.052	2.38*
	Immersion dummy[a]	-0.094	0.056	-1.69
	Male	0.034	0.062	0.55
	Hispanic	0.024	0.056	0.43
	African American	-0.011	0.073	-0.15
	Experience	-0.005	0.002	-2.22*
Student Classroom Activities				
	Initial status (fall 2004)	1.868	0.071	26.34***
	Immersion dummy	0.062	0.061	1.01
	Male	-0.034	0.080	-0.42
	Hispanic	0.250	0.059	4.20***
	African American	0.449	0.083	5.41***
	Experience	-0.007	0.004	-1.71
	Growth rate	0.044	0.024	1.82[#]
	Immersion dummy	0.285	0.036	7.98***
	Male	0.022	0.043	0.50
	Hispanic	-0.016	0.027	-0.60
	African American	-0.014	0.073	-0.19
	Experience	0.000	0.002	-0.03

(*Continued*)

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

Collaboration				
	Initial status (fall 2004)	2.298	0.068	34.02***
	Immersion dummy[b]	0.147	0.075	1.96*
	Male	0.034	0.059	0.58
	Hispanic	0.127	0.056	2.28*
	African American	0.502	0.091	5.53***
	Experience	-0.008	0.003	-2.60*
	Growth rate	0.061	0.033	1.86[#]
	Immersion dummy[b]	0.152	0.041	3.70**
	Male	-0.049	0.021	-2.38*
	Hispanic	0.034	0.030	1.15
	African American	-0.122	0.066	-1.85
	Experience	0.000	0.001	0.36

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

[a] Immersed teachers had significantly lower initial resistance to integration scores. A latent variable regression was used to control for this initial difference. This analysis indicated that there was not a significant immersion effect on resistance to integration growth rate (t for immersion dummy = 0.23, p = 0.817).

[b] Immersed teachers had significantly higher initial levels of collaboration scores. A latent variable regression was used to control for this initial difference. This analysis indicated that there was still a significant immersion effect on collaboration growth rate (t for immersion dummy = 5.88, p = 0.001). The difference between the original and adjusted coefficients was not significant (t = 1.70).

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	0.2927			
Level-2 individual initial status	1.5736	756	5429.65	0.000
Level-2 individual growth rate	0.0694	756	1153.92	0.000
Level-2 school initial status	0.0217	40	50.63	0.121
Level-2 school growth rate	0.0091	40	75.69	0.001
Professional Productivity				
Level-1 temporal variation	0.1454			
Level-2 individual initial status	0.2832	751	2243.76	0.000
Level-2 individual growth rate	0.0105	751	906.61	0.000
Level-2 school initial status	0.0271	40	95.02	0.000
Level-2 school growth rate	0.0026	40	72.75	0.001
Technology Integration				
Level-1 temporal variation	0.6090			
Level-2 individual initial status	1.2483	737	2431.18	0.000
Level-2 individual growth rate	0.0296	737	829.10	0.010
Level-2 school initial status	0.0419	40	61.51	0.016
Level-2 school growth rate	0.0337	40	107.74	0.000
Learner-Centered Instruction				
Level-1 temporal variation	0.6902			
Level-2 individual initial status	0.9411	747	2012.51	0.000
Level-2 individual growth rate	0.0362	747	867.13	0.002
Level-2 school initial status	0.0103	40	54.57	0.062
Level-2 school growth rate	0.0179	40	74.97	0.001
Resistance to Integration				
Level-1 temporal variation	0.7280			
Level-2 individual initial status	0.7004	786	1687.90	0.000
Level-2 individual growth rate	0.0754	745	952.49	0.000
Level-2 school initial status	Effect Not Random			
Level-2 school growth rate	0.0108	40	66.87	0.005
Student Classroom Activities				
Level-1 temporal variation	0.1921			
Level-2 individual initial status	0.2862	749	2091.54	0.000
Level-2 individual growth rate	0.0132	749	890.97	0.000
Level-2 school initial status	0.0104	40	62.24	0.014
Level-2 school growth rate	0.0051	40	82.15	0.000
Collaboration				
Level-1 temporal variation	0.2289			
Level-2 individual initial status	0.2482	749	1669.44	0.000
Level-2 individual growth rate	0.0164	749	903.43	0.000
Level-2 school initial status	0.0282	40	93.19	0.000
Level-2 school growth rate	0.0083	40	88.06	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 1 and 2 using two- and three-level HLM models.

Effects on Mediating Variables

Cohort 1. 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 1. We analyzed more complex growth models, including controls for other student demographic variables (gender, ethnicity, home Internet access). Since these models yielded immersion growth coefficients nearly identical to those reported in Tables E.7, E.8 and E.9, results are not provided in this report.

Table E.7. Descriptive Statistics for Student Variables, Cohort 1

Variable Name	*N*	*Mean*	*SD*
Repeated Measure Descriptive Statistics (Level 1)			
Time	9,300	1.00	0.82
Technology Proficiency score	9,054	3.13	0.90
Technology Use in School score	8,423	2.29	0.83
Technical Problems score	8,717	2.42	0.93
Small-Group Work score	8,565	2.79	0.87
School Satisfaction score	8,713	3.69	0.75
Self-Directed Learning score	8,263	4.48	0.75
Student-Level Descriptive Statistics (Level 2)			
Eco. disadvantaged (1 = yes, 0 = no)	3,100	0.73	0.45
School-Level Descriptive Statistics (Level 3)			
Immersion status (1 = yes, 0 = no)	42	0.50	0.51
School poverty (percentage)	42	68.58	17.56

Table E.8. Immersion (Fixed) Effect Analyses of Student Mediating Variables, Cohort 1

School-Level Scale	School-Level Analysis	Gamma Coefficient	Standard Error	*t*
Technology Proficiency				
	Initial status (fall 2004)	3.031	0.058	51.89***
	Immersion dummy	-0.037	0.084	-0.44
	School poverty	0.000	0.003	-0.14
	Disadvantaged	-0.361	0.040	-9.12***
	Growth rate	0.210	0.026	8.08***
	Immersion dummy	0.198	0.044	4.53***
	School poverty	-0.001	0.001	-0.52
	Disadvantaged	0.060	0.017	3.49**
Self-Directed Learning				
	Initial status (fall 2004)	4.551	0.042	107.67***
	Immersion dummy[b]	0.105	0.051	2.08*
	School poverty	0.003	0.001	2.26*
	Disadvantaged	-0.039	0.037	-1.07
	Growth rate	-0.068	0.019	-3.59**
	Immersion dummy[b]	-0.025	0.024	-1.04
	School poverty	-0.001	0.001	-0.82
	Disadvantaged	-0.029	0.018	-1.60

(*Continued*)

Table E.8. Immersion (Fixed) Effect Analysis of Student Variables, Cohort 1 (Continued)

School Satisfaction				
	Initial status (fall 2004)	3.807	0.041	92.69***
	Immersion dummy	0.047	0.040	1.18
	School poverty	0.000	0.001	-0.21
	Disadvantaged	-0.091	0.032	-2.89**
	Growth rate	-0.094	0.019	-4.92***
	Immersion dummy	0.016	0.023	0.72
	School poverty	0.001	0.001	2.23*
	Disadvantaged	0.033	0.015	2.18*
Classroom Activities				
(with technology)	Initial status (fall 2004)	2.039	0.062	33.02***
	Immersion dummy	0.133	0.081	1.64
	School poverty	-0.002	0.002	-0.72
	Disadvantaged	0.005	0.030	0.17
	Growth rate	0.031	0.026	1.17
	Immersion dummy	0.323	0.059	5.46***
	School poverty	0.000	0.002	0.09
	Disadvantaged	0.058	0.021	2.83**
Small-Group Work				
	Initial status (fall 2004)	2.826	0.055	51.64***
	Immersion dummy	0.001	0.062	0.01
	School poverty	-0.002	0.002	-0.90
	Disadvantaged	-0.049	0.056	-0.86
	Growth rate	-0.105	0.027	-3.89**
	Immersion dummy	0.173	0.043	4.05***
	School poverty	0.000	0.001	-0.20
	Disadvantaged	0.063	0.034	1.86†
Technical Problems				
	Initial status (fall 2004)	2.362	0.059	39.94***
	Immersion dummy[a]	-0.140	0.075	-1.88†
	School poverty	-0.003	0.003	-1.17
	Disadvantaged	-0.078	0.059	-1.33
	Growth rate	0.100	0.030	3.30**
	Immersion dummy[a]	0.084	0.054	1.55
	School poverty	0.001	0.002	0.36
	Disadvantaged	0.060	0.029	2.08*

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

[a]Immersion students had borderline significantly lower initial technical problems scores. A latent variable regression, controlling for the effect of this initial difference on the growth rate, indicated that the difference between the original and adjusted immersion coefficients was not significant (the difference divided by the standard error of the difference = 1.76).

[b]Immersion students had significantly higher initial technical self-directed learning scores. A latent variable regression, controlling for the effect of this initial difference on the growth rate, indicated that the difference between the original and adjusted immersion coefficients was not significant (the difference divided by the standard error of the difference = 1.44).

Table E.9. Variance Decomposition from Conditional HLM Models of Student Mediating Variables, Cohort 1

Scale/ Random Effect	Variance Component	*df*	X^2	*p*
Technology Proficiency				
Level-1 temporal variation	0.2934			
Level-2 individual initial status	0.4521	3041	8525.47	0.000
Level-2 individual growth rate	0.0367	3041	3790.18	0.000
Level-2 school initial status	0.0636	39	293.64	0.000
Level-2 school growth rate	0.0172	39	351.94	0.000
Self-Directed Learning				
Level-1 temporal variation	0.2267			
Level-2 individual initial status	0.3362	2883	7618.66	0.000
Level-2 individual growth rate	0.0250	2883	3477.81	0.000
Level-2 school initial status	0.0152	39	122.12	0.000
Level-2 school growth rate	0.0030	39	102.41	0.000
School Satisfaction				
Level-1 temporal variation	0.3363			
Level-2 individual initial status	0.2142	3005	5190.24	0.000
Level-2 individual growth rate	0.0182	3005	3378.01	0.000
Level-2 school initial status	0.0078	39	84.87	0.000
Level-2 school growth rate	0.0022	39	70.22	0.002
Classroom Activities				
Level-1 temporal variation	0.4228			
Level-2 individual initial status	0.1416	3050	5838.58	0.000
Level-2 individual growth rate	Effect Not Random			
Level-2 school initial status	0.0565	39	261.98	0.000
Level-2 school growth rate	0.0330	39	345.21	0.000
Small-Group Work				
Level-1 temporal variation	0.5094			
Level-2 individual initial status	0.2503	2968	4597.65	0.000
Level-2 individual growth rate	0.0358	2968	3394.22	0.000
Level-2 school initial status	0.0252	39	124.48	0.000
Level-2 school growth rate	0.0128	39	146.56	0.000
Technical Problems				
Level-1 temporal variation	0.5268			
Level-2 individual initial status	0.2547	3012	4679.02	0.000
Level-2 individual growth rate	0.0620	3012	3700.39	0.000
Level-2 school initial status	0.0396	39	210.58	0.000
Level-2 school growth rate	0.0229	39	252.61	0.000

Cohort 2. Researchers' used two-level HLM models, with controls for fall scale scores, student demographic characteristics (gender, ethnicity, economic disadvantage), and school poverty (percentage of economically disadvantaged students) and student poverty (qualification for free- or reduced-price lunch), to estimate the effects of immersion on student mediating variables for Cohort 2. Statistical details for are provided in Tables E.10, E.11, and E.12.

Table E.10. Descriptive Statistics for Student Mediating Variables, Cohort 2

Variable Name	*N*	*Mean*	*SD*
Student-Level Descriptive Statistics (Level 1)			
Female	4,021	0.50	0.50
Hispanic	4,020	0.68	0.47
African American	4,020	0.07	0.26
Eco. disadvantaged (1 = yes, 0 = no)	4,019	0.73	0.44
Technology Proficiency (fall 2005)	3,820	2.84	0.89
Technology Proficiency (spring 2006)	3,917	3.25	0.84
Self-Directed Learning (fall 2005)	3,364	4.67	0.74
Self-Directed Learning (spring 2006)	3,586	4.54	0.70
School Satisfaction (fall 2005)	3,612	3.76	0.75
School Satisfaction (spring 2006)	3,808	3.72	0.74
Classroom Activities (fall 2005)	3,564	2.09	0.85
Classroom Activities (spring 2006)	3,669	2.45	0.80
Small-Group Work (fall 2005)	3,538	2.75	0.91
Small-Group Work (spring 2006)	3,743	2.81	0.86
Technical Problems (fall 2005)	3,653	2.04	0.88
Technical Problems (spring 2006)	3,769	2.37	0.87
School-Level Descriptive Statistics (Level 2)			
Immersion status (1 = yes, 0 = no)	42	0.50	0.51
School poverty (percentage)	42	68.58	17.56

Table E.11. Immersion (Fixed) Effect Analyses of Student Mediating Variables, Cohort 2

School-Level Scale	School-Level Analysis	Gamma Coefficient	Standard Error	*t*
Technology Proficiency				
	Base	3.229	0.054	60.01***
	Immersion dummy	0.251	0.071	3.52**
	School poverty	0.001	0.002	0.71
	Female	0.074	0.018	4.19***
	Hispanic	-0.064	0.028	-2.31*
	African American	-0.111	0.048	-2.29*
	Disadvantaged	-0.125	0.035	-3.63**
	Fall 2005 score	0.477	0.023	20.72***
Self-Directed Learning				
	Base	4.593	0.029	155.85***
	Immersion dummy	-0.023	0.032	-0.73
	School poverty	0.001	0.001	1.69†
	Female	0.030	0.026	1.15
	Hispanic	-0.029	0.029	-0.98
	African American	0.037	0.041	0.90
	Disadvantaged	-0.027	0.026	-1.03
	Fall 2005 score	0.556	0.020	27.70***
School Satisfaction				
	Base	3.688	0.033	110.37***
	Immersion dummy	-0.008	0.033	-0.23
	School poverty	-0.001	0.001	-1.20
	Female	0.113	0.026	4.44***
	Hispanic	0.068	0.030	2.28*
	African American	0.073	0.073	1.00
	Disadvantaged	-0.092	0.027	-3.42**
	Fall 2005 score	0.345	0.023	15.23***
Classroom Activities				
(with technology)	Base	2.118	0.061	34.77***
	Immersion dummy	0.663	0.092	7.17***
	School poverty	0.003	0.003	1.03
	Female	-0.003	0.023	-0.13
	Hispanic	0.048	0.036	1.33
	African American	0.142	0.045	3.15**
	Disadvantaged	0.014	0.034	0.42
	Fall 2005 score	0.234	0.014	16.55***
Small-Group Work				
	Base	2.610	0.057	45.61***
	Immersion dummy	0.214	0.067	3.17**
	School poverty	0.001	0.002	0.26
	Female	0.096	0.033	2.91**
	Hispanic	0.092	0.045	2.06*
	African American	0.197	0.052	3.75***
	Disadvantaged	-0.009	0.039	-0.24
	Fall 2005 score	0.227	0.020	11.65***
Technical Problems				
	Base	2.361	0.059	39.92***
	Immersion dummy	0.046	0.076	0.61
	School poverty	0.005	0.002	2.22*
	Female	0.013	0.028	0.49
	Hispanic	-0.055	0.037	-1.49
	African American	0.074	0.064	1.17
	Disadvantaged	-0.043	0.031	-1.38
	Fall 2005 score	0.202	0.027	7.42***

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

Table E.12. Variance Decomposition from Conditional HLM Models of Student Mediating Variables, Cohort 2

Scale/ Random Effect	Variance Component	*df*	X^2	*p*
Technology Proficiency				
Level-1 student effect	0.4322			
School mean	0.0526	39	364.79	0.000
School pretest-outcome slope	0.0108	41	102.77	0.000
Self-Directed Learning				
Level-1 student effect	0.3231			
School mean	0.0066	39	87.46	0.000
School pretest-outcome slope	0.0058	41	62.04	0.018
School Satisfaction				
Level-1 student effect	0.4621			
School mean	0.0046	39	65.92	0.005
School pretest-outcome slope	0.0088	41	74.04	0.001
Classroom Activities				
Level-1 student effect	0.4734			
School mean	0.0895	39	591.95	0.000
School pretest-outcome slope	Effect Not Random			
Small-Group Work				
Level-1 student effect	0.6505			
School mean	0.0456	39	194.02	0.000
School pretest-outcome slope	0.0041	41	56.88	0.050
Technical Problems				
Level-1 student effect	0.6827			
School mean	0.0494	39	280.58	0.000
School pretest-outcome slope	Effect Not Random			

Effects on School Attendance

Comparable to analyses for student-level variables, we used three-level HLM growth models and two-level HLM analyses 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 1 Repeated Measures Descriptive Statistics (Level 1)			
Year	13,194	1.00	0.82
Attendance	13,094	96.68	4.00
Cohort 1 Student-Level Descriptive Statistics (Level 2)			
Eco. disadvantaged (1 = yes, 0 = no)	4,398	0.74	0.44
Cohort 1 School-Level Descriptive Statistics (Level 3)			
Immersion status (1 = yes, 0 = no)	42	0.50	0.51
School poverty	42	68.58	17.56
Cohort 2 Student-Level Descriptive Statistics (Level 1)			
Attendance 2006	4,398	96.11	4.61
Attendance 2004	4,298	97.24	3.47
Eco. disadvantaged (1 = yes, 0 = no)	4,019	0.73	0.44
Hispanic (1 = yes, 0 = no)			
African American (1 = yes, 0 = no)			
Female (1 = yes, 0 = no)			
Cohort 2 School-Level Descriptive Statistics (Level 2)			
Immersion status (1 = yes, 0 = no)	42	0.50	0.51
School poverty	42	68.58	17.56

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

Group	School-Level Analysis	Gamma Coefficient	Standard Error	*t*
Cohort 1				
	Initial attendance (2004)	97.076	0.157	616.69***
	Immersion dummy	-0.053	0.224	-0.24
	School poverty	0.022	0.005	4.41***
	Eco. disadvantaged	-0.702	0.132	-5.31***
	Growth rate	-0.355	0.067	-5.27***
	Immersion dummy	-0.217	0.100	-2.18*
	School poverty	-0.005	0.003	-1.84†
	Eco. disadvantaged	-0.154	0.082	-1.86†
Cohort 2				
	Base	96.922	0.186	520.22***
	Immersion dummy[a]	-0.268	0.146	-1.83†
	School poverty	0.001	0.006	0.25
	Prior attendance	0.627	0.030	20.73***
	Eco. disadvantaged	-0.560	0.146	-3.83***
	Female	0.242	0.134	1.81†
	Hispanic	0.115	0.208	0.55
	African American	-0.329	0.386	-0.85

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

Table E.15. Variance Decomposition from Conditional HLM Models of Student attendance, Cohorts 1 and 2

Cohort/ Random Effect	Variance Component	*df*	X^2	*pt*
Cohort 1				
Level-1 temporal variation	4.5052			
Level-2 individual initial status	6.7248	4355	12027.70	0.000
Level-2 individual growth rate	1.9582	4355	8105.03	0.000
Level-2 school initial status	0.3679	39	180.00	0.000
Level-2 school growth rate	0.0487	39	94.78	0.000
Cohort 2				
Level-1 student effect	11.4126			
School mean	0.1040	39	70.388	0.002
School pre-measure-outcome slope	0.0236	41	137.933	0.000

Effects of Technology Immersion on Student Achievement (Chapter 6)

Researchers used two-level HLM models and three-level HLM growth models to estimate the effects of immersion on student academic achievement. Statistical details are provided for Cohort 1 students (seventh graders) in Tables E.16 through E.19, and for Cohort 2 students (sixth graders) in Tables E.20 through E.22.

Cohort 1 (Seventh Graders)

Table E.16. Descriptive Statistics for TAKS Reading and Mathematics, Cohort 1

Variable Name	*N*	*Mean*	*SD*
Repeated Measures Descriptive Statistics: Reading (Level 1)			
Time	10,257	1.00	0.82
TAKS Reading T score	10,257	48.28	9.82
Repeated Measures Descriptive Statistics: Mathematics (Level 1)			
Time	10,350	1.00	0.82
TAKS Mathematics T score	10,350	48.40	9.53
Student-Level Descriptive Statistics: Reading (Level 2)			
Eco. disadvantaged (1 = yes, 0 = no)	3,419	0.70	0.46
Student-Level Descriptive Statistics: Mathematics (Level 2)			
Eco. disadvantaged (1 = yes, 0 = no)	3,450	0.71	0.46
School-Level Descriptive Statistics (Level 3)			
Immersion status (1 = yes, 0 = no)	42	0.50	0.51
School poverty (percent)	42	68.58	17.56

Table E.17. Descriptive Statistics for TAKS Writing, Cohort 1

Variable Name	*N*	*Mean*	*SD*
Student-Level Descriptive Statistics : Writing (Level 1)			
Female	3,126	0.52	0.50
African American	3,126	0.06	0.24
Hispanic	3,126	0.68	0.47
Eco. disadvantaged (1 = yes, 0 = no)	3,126	0.70	0.46
TAKS Writing T score (2003)	3,126	47.46	8.10
TAKS Writing T score (2006)	3,126	49.23	9.23
School-Level Descriptive Statistics (Level 2)			
Immersion status (1 = yes, 0 = no)	42	0.50	0.51
School poverty (percent)	42	68.58	17.56

Table E.18. 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)	53.834	0.635	84.75***
	Immersion dummy[a]	-1.350	0.649	-2.08*
	School poverty	-0.064	0.014	-4.71***
	Eco. disadvantaged	-6.384	0.666	-9.58***
	Growth rate	-0.547	0.190	-2.87**
	Immersion dummy[a]	0.257	0.246	1.05
	School poverty	0.007	0.008	0.84
	Eco. disadvantaged	0.461	0.191	2.41*
Mathematics				
	Initial status (spring 2004)	52.813	0.659	80.17***
	Immersion dummy[a]	-1.074	0.829	-1.30
	School poverty	-0.047	0.018	-2.61*
	Eco. disadvantaged	-4.558	0.506	-9.01***
	Growth rate	-0.315	0.265	-1.19
	Immersion dummy[a]	0.220	0.445	0.49
	School poverty	0.008	0.012	0.61
	Eco. disadvantaged	-0.285	0.149	-1.91[†]
Writing				
	Base	51.116	0.650	78.70***
	Immersion dummy	-0.907	0.616	-1.47
	School poverty	-0.011	0.017	-0.63
	Female	2.237	0.356	6.29***
	African American	-2.241	0.553	-4.05***
	Hispanic	-1.162	0.345	-3.37**
	Eco. disadvantaged	-1.712	0.507	-3.38**
	Spring 2003 T score	0.617	0.020	30.28***

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

[a]Immersion students had significantly lower initial TAKS reading scores. A latent variable regression, controlling for the effect of this initial difference on the growth rate, indicated that the difference between the original and adjusted immersion coefficients was not significant (the difference divided by the standard error of the difference = 0.26).

Table E.19. 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	22.5847			
Level-2 individual initial status	55.1410	3376	13268.14	0.000
Level-2 individual growth rate	1.3225	3376	3773.09	0.000
Level-2 school initial status	2.8666	39	160.85	0.000
Level-2 school growth rate	0.4114	39	141.44	0.000
Mathematics				
Level-1 temporal variation	20.3428			
Level-2 individual initial status	57.0502	3407	14868.56	0.000
Level-2 individual growth rate	0.7548	3407	3660.25	0.002
Level-2 school initial status	5.6630	39	233.15	0.000
Level-2 school growth rate	1.8953	39	485.15	0.000
Writing				
Level-1 student effect	47.4347			
School mean	3.4650	39	191.57	0.000
School pre-measure-outcome slope	0.0054	41	59.64	0.030

Cohort 2 (Sixth Graders)

Table E.20. Descriptive Statistics for TAKS Achievement, Cohort 2

Variable Name	*N*	*Mean*	*SD*
Student-Level Descriptive Statistics: Reading (Level 1)			
Female	3,789	0.52	0.50
African American	3,789	0.07	0.26
Hispanic	3,789	0.67	0.47
Eco. disadvantaged (1 = yes, 0 = no)	3,789	0.71	0.45
TAKS Reading T score (2005)	3,789	48.59	9.54
TAKS Reading T score (2006)	3,789	48.01	9.71
Student-Level Descriptive Statistics : Mathematics (Level 1)			
Female	3,838	0.52	0.50
African American	3,838	0.07	0.26
Hispanic	3,838	0.67	0.47
Eco. disadvantaged (1 = yes, 0 = no)	3,838	0.71	0.45
TAKS Mathematics T score (2005)	3,838	48.50	9.37
TAKS Mathematics T score (2006)	3,838	47.39	9.18
School-Level Descriptive Statistics (Level 2)			
Immersion status (1 = yes, 0 = no)	42	0.50	0.51
School poverty (percent)	42	68.58	17.56

Table E.21. Immersion (Fixed) Effect Analyses of Cohort 2 Achievement

TAKS Achievement Test	School-Level Analysis	Gamma Coefficient	Standard Error	*t*-value
Reading				
	Base	48.828	0.450	108.41***
	Immersion dummy	0.236	0.428	0.55
	School poverty	-0.025	0.013	-1.91†
	Female	1.518	0.213	7.11***
	African American	-0.957	0.361	-2.65**
	Hispanic	-0.869	0.388	-2.24*
	Eco. disadvantaged	-1.218	0.355	-3.43**
	Spring 2005 T score	0.648	0.027	24.03***
	Immersion dummy	0.011	0.033	0.34
Mathematics				
	Base	48.067	0.495	97.03***
	Immersion dummy	0.950	0.751	1.27
	School poverty	-0.020	0.018	-1.11
	Female	0.816	0.229	3.56**
	African American	-1.961	0.516	-3.80***
	Hispanic	-0.752	0.298	-2.52*
	Eco. disadvantaged	-1.027	0.257	-4.00***
	Spring 2005 T score	0.680	0.021	31.69***
	Immersion dummy	0.050	0.025	1.97*

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

Table E.22. Variance Decomposition from Conditional HLM Models of Student Achievement, Cohort 2

Test/ Random Effect	Variance Component	*df*	X^2	*p*
Reading				
Level-1 student effect	45.3648			
School mean	1.3513	39	113.32	0.000
School pre-measure-outcome slope	0.0041	40	62.77	0.012
Mathematics				
Level-1 student effect	34.0634			
School mean	5.6026	39	560.78	0.000
School pre-measure-outcome slope	0.0020	40	52.44	0.090