eTxTIP

# Evaluation of the Texas Technology Immersion Pilot

## Outcomes for the Third Year (2006–07)

January 2008

**Prepared for**
**Texas Education Agency**

**Prepared by**
**Texas Center for Educational Research**

TCER
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# Executive Summary

The Technology Immersion Pilot (TIP), created by the Texas Legislature in 2003, set forth a vision for technology immersion in public schools. Senate Bill 396 called for the Texas Education Agency (TEA) to establish a pilot project to "immerse" schools in technology by providing a wireless mobile computing device for each teacher and student, technology-based learning resources, training for teachers to integrate technology into the classroom, and support for effective technology use. In response to this non-funded legislative mandate, the TEA has used more than $20 million in federal Title II, Part D monies to fund *technology immersion* projects for high-need middle schools through a competitive grant process. Concurrently, a research study, partially funded by a federal Evaluating State Educational Technology Programs grant, 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 for this four-year evaluation that began in the 2004-05 school year and will continue through 2007-08.

## Technology Immersion

State statute provided a general description of technology immersion, but the concept and its component parts were defined operationally to foster uniformity. As a way to ensure consistent interpretation of the technology immersion model and comparability of implementation across schools, the TEA issued a Request for Qualifications (RFQ) that allowed commercial vendors to apply to become providers of technology immersion packages. Vendors had to include six components in their plan: (a) a wireless mobile computing device for each educator and student on an immersed campus to ensure on-demand technology access; (b) productivity, communication, and presentation software for use as learning tools; (c) online instructional resources that support the state curriculum in English language arts, mathematics, science, and social studies; (d) online assessment tools to diagnose students' strengths and weaknesses or to assess mastery of the core curriculum; (e) professional development for teachers to help them integrate technology into teaching, learning, and the curriculum; and (f) initial and ongoing technical support.

Through an expert review process, the TEA selected three lead vendors as providers of technology immersion packages (Dell Computer Inc., Apple Computer Inc., and Region 1 Education Service Center [ESC]). Package costs, which ranged from about $1,100 to $1,600 per student, varied according to the numbers of students and teachers, the type of laptop computer, and the vendor provider. Of the 21 immersion sites studied in the third year, 5 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 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). The evaluation also examines the relationships that exist among contextual conditions, technology immersion, intervening factors (school, teacher, and student), and student achievement. The research design is quasi-experimental with middle schools assigned to either treatment or control groups. This report concentrates on information gathered during the 2006-07 school year, but analyses also include data from the first (2004-05) and second (2005-06) project years. Researchers answered the following questions:

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

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.

## Setting and Participants

The research includes 42 grades 6 to 8 middle schools drawn from rural, suburban, and urban locations in Texas. Schools are divided equally between the treatment group (21) and control group (21). The middle schools are typically small (402 students, on average); however, enrollments vary widely (from 83 to 1,447 students). While schools are mainly concentrated in small or very small Texas districts (less than 3,000 students), about a third of schools are in very large districts (10,000 or more students).

The study focused on three student cohorts in the third year. Cohort 1 included eighth graders (2,586 treatment, 2,863 control) who completed their third project year, Cohort 2 included seventh graders (2,644 treatment, 2,882 control) who finished their second project year, and Cohort 3 included sixth graders (2,597 treatment, 2,840 control) who concluded their first year. Students in the cohorts were predominantly minority (65%) and economically disadvantaged (67%). In the third year, a total of 1,253 teachers participated in the study, including 591 in immersion schools and 662 in control schools.

## 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 again in spring 2005, 2006, and 2007. For this report, we concentrate on data gathered through observations in a sample of grades 6, 7, and 8 classrooms (English language arts, mathematics, social studies, and science). Additional measures include annual online teacher surveys and student paper-and-pencil surveys. We also have gathered school and student data on a yearly basis from the Texas Public Education Information Management

System (PEIMS) and the Academic Excellence Indicator System (AEIS), as well as 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, immersion effects on students' TAKS achievement, and associations between implementation and outcomes. Three-level HLM growth modeling estimated the effects of immersion on rates of growth for dependent variables across time (2004, 2005, 2006, and 2007). When only two data points were available, we used two-level HLM models to estimate the effects of immersion on 2007 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 to 0.1 as small, and less than 0.1 as trivial.

### Study Limitations

The sample selection process and matching procedures used with the quasi-experimental design appear to have produced a sample of schools with good internal validity, in that there are no large, statistically significant treatment-control group differences. However, a threat to internal validity was introduced in the third year when control schools began to plan for technology immersion and most of the control teachers received laptops, instructional resources, and more intensive professional development. Generalization of findings to a broader population (external validity) is a primary study limitation. Compared to Texas middle-school students as a whole, students in the sample schools are substantially more Hispanic and less White and African American. Middle schools are also smaller than the statewide average, and schools are located either in small or very small districts (64%) or large districts (36%), which differs from the statewide distribution of schools. Additionally, for many variables, the study relies on self-reported data from surveys of teachers and students—thus, some findings on changes in proficiencies and practices reflect respondents' perceptions. Nonetheless, the triangulation of evidence from multiple sources (surveys, classroom observations, state demographic and test databases, multiple student cohorts) verifies the robustness of findings.

## Major Findings

### *Effects of Technology Immersion on Teachers and Teaching*

**In the third year, immersion teachers continued to grow in technology proficiency and in their use of technology for professional productivity at significantly faster rates than control teachers.** Technology immersion has accelerated teachers' growth in meeting the state's Technology Application Standards. In a self-assessment of their technology proficiency across four 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 are using technology significantly more often for management purposes, such as communicating with students through email and websites, administering assessments, and accessing model lesson plans.

**Teachers at schools with higher concentrations of student poverty grew in technology proficiency at a slower rate.** Consistent with previous years, teachers who taught at schools with higher levels of student poverty grew in technology proficiency at significantly slower rates than their peers in more advantaged schools. Weaker supports for implementation at higher poverty immersion schools may at least partially explain teachers' slower progress.

**Teachers in immersion schools expressed increasingly stronger ideological associations across years with technology integration and learner-centered practices.** Although immersion and control teachers initially expressed similar views on instructional practices involving technology, immersion teachers altered their instructional beliefs at a significantly faster rate. Thus, immersion teachers increasingly employed actions supporting curricular and instructional infusion of technology. Immersion teachers also expressed increasingly stronger affiliations across years with constructivist or learner-centered practices, such as having students establish individual learning goals and emphasizing experiential learning.

**Teachers at immersion schools had more collegial interactions on technology-related issues than control teachers, and students used technology more often in immersion classrooms.** Teachers at immersion schools reported increasingly more frequent collaborative interactions with their colleagues that supported instructional practices involving technology than control teachers (e.g., developing lesson plans or exchanging information about students), and immersion teachers increased the frequency of their students' Classroom Activities involving technology at a more rapid pace. Although student activities with technology have steadily increased in immersion classrooms, third-year statistics indicted that students still used various technology resources infrequently (i.e., about once or twice a month). While the overall level of classroom technology activities remained low, practices varied substantially across teachers and core-subject areas.

**Cumulative evidence suggests that laptop computers and digital resources have allowed students in technology immersion schools to experience slightly more intellectually demanding work.** New resources in technology immersion schools and classrooms are expected to promote students' higher level thinking through more challenging and relevant learning activities that support academic achievement. Although observations of core-subject classes in spring of 2005, 2006, and 2007 revealed no statistically significant differences between the overall Intellectual Challenge of immersion and control teachers' instruction, the sizes of effects favoring immersion teachers increased across years. In particular, immersion teachers' lessons compared to control had a greater emphasis on Higher Order Thinking over time. Across both immersion and control classrooms, however, the intellectual demand of instruction was typically low (mostly below 2 on the 5-point challenge scale).

### *Effects of Technology Immersion on Students and Learning*

**Technology immersion significantly increased students' technology proficiency and reduced the proficiency gap between economically advantaged and disadvantaged students.** Across three cohorts, students in technology immersion schools have made greater progress in mastering the Texas Technology Applications standards than control students. Technology immersion had a positive and enduring effect on the technology proficiencies of Cohort 1 students from lower socioeconomic backgrounds. By the end of the third year, economically disadvantaged eighth graders in immersion schools were growing in proficiency at a significantly faster yearly rate than their more affluent immersion peers and control-group students. For Cohort 2 (seventh graders) and Cohort 3 (sixth graders), technology immersion had a significantly positive effect on technology proficiency for both economically advantaged and disadvantaged immersion students.

**Technology immersion significantly increased the frequency of students' classroom technology use and their interactions with peers in small-group activities.** Across three cohorts, students in immersion schools used technology applications significantly more often in their core-subject classrooms than control students. Despite significant increases, third-year statistics (similar to teachers' reports) indicated that students used technology resources infrequently in core classrooms (about once or twice a month). Students in immersion schools also had more frequent opportunities to learn in small groups with their classmates, whereas control students reported less frequent small-group activities as they advanced to higher grade levels. In general, as immersion teachers altered their beliefs about instructional practices, they began to configure classroom activities differently.

**Students at immersion schools, compared to control, reported mounting technical problems over time when they used computers at school.** Cohorts 1 and 2 immersion students reported increasing technical problems using computers across years compared to control students, with the growth in problems statistically significant for Cohort 1. Cohort 3 students at immersion schools (sixth graders), who inherited laptops that had been used by students during two previous school years, also reported significantly more technical problems than control students. Although increased problems appeared to accompany aging laptops, mean scores in spring 2007 indicated that students, on average, rarely (a few times a year) or just sometimes (once or twice a month) had problems using computers at school.

**Technology immersion and control students regarded themselves as similarly self-directed learners.** Since the independent and self-guided learning afforded through one-to-one technology was expected to positively affect students' personal self-direction, we asked students to complete the Style of Learning Inventory as a measure of Self-Directed Learning. Findings in the third year replicated first- and second-year results showing there was no significant immersion effect on students' self-direction. In fact, as both immersion and control students in Cohorts 1 and 2 progressed from lower to higher grade levels, their responses to statements measuring self-direction revealed significantly negative growth trends. Thus, students reported less self-regulated learning behaviors across time.

**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 increased student engagement as measured by indicators such as stronger commitment to academic work, reduced discipline problems, and increased school attendance. However, consistent results for three student cohorts involved in our study show that immersion students exhibited significantly stronger school engagement through more positive behavior, but they did not express greater satisfaction with school, and they attended school less regularly than control students.

- **Behavior and discipline.** Disciplinary Action Reports for each student during the 2006-07 school year, similar to the previous two years, showed that immersion students had proportionately fewer behavioral and disciplinary problems than their counterparts in control schools. Cohorts 1, 2, and 3 immersion students had an average of 0.65, 0.53, and 0.47 disciplinary actions, respectively, compared to 0.90, 0.86, and 0.75 for control students.
- **School satisfaction.** For each of three cohorts, there was no significant difference in the school satisfaction expressed by students at immersion and control schools in the third year.
- **School attendance.** Contrary to expectations, across three cohorts, students in immersion schools had significantly lower school attendance rates than control-group students. For example, at the end of eighth grade, Cohort 1 advantaged students in immersion schools had an average attendance rate of 96.3% compared to 97.2% for control students. Economically disadvantaged immersion students, similarly, had significantly lower attendance rates than their control-group counterparts. Surprisingly, as detailed in the section to follow, immersion students' lower average school attendance was not always associated with lower academic achievement. This contrasts with other research linking lower school attendance rates with lower test scores.

### *Effects of Technology Immersion on Academic Achievement*

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. We used two-level HLM models and three-level HLM growth models to estimate the effects of immersion on students' test scores. Texas students complete TAKS tests annually in reading and mathematics, so reported evidence is stronger for those subject areas. In contrast, evidence for science, social studies, and writing is limited because students complete those assessments periodically.

**Technology immersion had no statistically significant effect on students' TAKS reading achievement.** After controlling for student and school poverty, there were no statistically significant effects of immersion on the TAKS reading growth rates for either Cohort 1 (eighth graders) or Cohort 2 (seventh graders). The immersion effects were positive but not by significant margins. Across cohorts, economically disadvantaged students grew in reading achievement at significantly faster rates than their more affluent peers. For disadvantaged immersion students, positive annual growth rates provided a substantial boost in reading achievement over time. For Cohort 3 sixth graders, after controls for students' prior achievement, demographic characteristics, and school poverty, there was no statistically significant effect of immersion on students' 2007 TAKS reading scores. Similar to the other cohorts, the immersion effect was positive but not by a significant degree.

**Technology immersion had a statistically significant effect on TAKS mathematics achievement, particularly for economically advantaged and higher achieving students.** After controlling for student and school poverty, technology immersion had a statistically significant effect on students' TAKS mathematics growth rates for Cohorts 1 and 2 students. For Cohort 1, a significant interaction effect revealed that economically advantaged students in immersion schools increased their math achievement at a significantly faster rate than disadvantaged immersion students, and at a faster rate than both economically advantaged and disadvantaged control-group students. For Cohort 2, economically advantaged and disadvantaged immersion students had TAKS mathematics growth rates that significantly outpaced their control-group counterparts. For Cohort 3 sixth graders, after controlling for students' prior achievement, demographic characteristics, and school poverty, there was a statistically significant effect of immersion that acted through students' pretest scores. Other factors being equal, as students' TAKS pretest scores increased, the achievement gap favoring immersion students over control widened for 2007 TAKS mathematics scores. Thus, immersion had a stronger and significant effect on math scores for higher achieving sixth graders.

**Students who had greater access to laptops and used laptops for learning to a greater extent, especially outside of school, had significantly higher TAKS reading and mathematics scores.** We used a series of HLM models to investigate the relationships between implementation levels and student academic achievement. Specifically, Student Access and Use was an aggregate implementation measure of the extent to which a student had access to a laptop throughout the school year (number of days), the frequency of technology use for learning in core-subject classes, and the extent of laptop use for homework and learning games. HLM results showed that Student Access and Use was a statistically significant positive predictor of students' TAKS reading and mathematics achievement for each of the three student cohorts. Of the three elements of Student Access and Use, students' use of their laptops for Home Learning—a measure of the extent to which students used laptops outside of school for homework in the four core-subject areas and for learning games—was the strongest predictor of both TAKS reading and mathematics achievement. In contrast, we found that reading and mathematics teachers' reported levels of Classroom Immersion were typically insignificant predictors of students' academic achievement. Results highlight the important role that individual laptops play in promoting ubiquitous learning and in equalizing the out-of-school learning opportunities for students in disadvantaged family and school situations.

**The effects of technology immersion on reading and mathematics achievement generally became stronger over time as teachers and students became more accomplished technology users.** The immersion effects on reading and mathematics achievement evolved across three project years. In the first project year, the immersion effects on TAKS scores were negative. In the second year, immersion effects were typically positive, but not by statistically significant margins. In the third year, significantly positive immersion effects on TAKS mathematics emerged for each of three student cohorts, and links were established between higher levels of student technology use and achievement. These findings underscore the importance of longitudinal studies in assessing the impacts of educational initiatives on student academic achievement.

**Evidence regarding the effects of technology immersion on students' TAKS social studies, science, and writing achievement is inconclusive.** Since TAKS tests for social studies, science, and writing are not administered annually, immersion effects for these subject areas cannot be replicated across cohorts and years. Accordingly, it is not possible to draw definitive conclusions about the effects of technology immersion for these subject areas. Available results typically show no statistically significant effects of immersion, with differences between groups favoring immersion students for TAKS social studies and control students for TAKS science and writing.

- **Social studies.** After controlling for Cohort 1 eighth graders' reading achievement (7th grade), demographic characteristics, and school poverty, there was no statistically significant effect of immersion on 2007 TAKS social studies scores. The immersion effect was positive but not by a significant degree.
- **Science.** After controlling for prior achievement (5th grade science score), demographic characteristics, and school poverty, there was no statistically significant effect of immersion on Cohort 1 eighth graders' TAKS science achievement. The immersion effect was negative, and a statistically significant interaction showed that as TAKS pretest scores increased, the achievement gap favoring control students over immersion widened for 2007 science scores. Thus, there was significantly negative effect on TAKS science scores for higher achieving eighth graders at immersion schools.
- **Writing.** For both Cohorts 1 and 2, after controlling for pretest writing scores (4th grade writing), demographic characteristics, and school poverty, there was no statistically significant effect of immersion on students' TAKS writing scores as seventh graders. The immersion effect was negative across both cohorts.

### *Nature of Third-Year Implementation*

**Although the overall level of implementation increased between the second and third project years, just a quarter of schools reached substantial levels of technology immersion.** Full implementation of the technology immersion model requires Leadership, Teacher Support (buy-in), Parent and Community Support, Technical Support, and Professional Development. Given adequate supports, teachers are expected to reach high levels of Classroom Immersion, and Student Access and Use of technology is expected to be robust. Mean immersion standard scores revealed small increases between the second and third implementation years for each of the immersion support components as well as for teachers' overall level of Classroom Immersion. In contrast, the level of Student Access and Use was stable across years. Although the quality of schools' implementation improved slightly in the third year, we estimate that about a quarter of middle schools (5) achieved *substantial immersion,* while the remaining schools (16) had *minimal* to *partial immersion* levels. Nevertheless, third-year results show that technology immersion can have positive effects on teachers and students even at lower implementation levels.

**School administrators advanced implementation through their provision of supports for teachers' technology immersion efforts, whereas teachers' greater support for immersion along with technical support elevated Student Access and Use.** Teachers' opinion of the strength of administrative leadership for technology at their school was significantly associated with their perceived levels of implementation support (i.e., collective support for technology innovation, parent and community support, the prevalence of technical support, and the robustness of professional development). Additionally, teachers' overall support for technology innovation and the extent to which they believed that the quality of technical support addressed infrastructure and maintenance issues causing barriers to students' laptop use, were significantly associated with greater Student Access and Use. To reach higher levels of immersion, many schools needed stronger supports for implementation in the third year.

**Core-subject teachers at the majority of schools reported only partial levels of Classroom Immersion in the third year; teachers at some schools, however, made collective progress in creating technology-immersed classrooms.** Immersion standard scores for each of five elements of Classroom Immersion showed slightly stronger implementation in the third year, with the largest increases for teachers' ideological affiliations with Technology Integration and Learner-Centered Instruction, and the smallest change for Student Activities with technology in the classroom. There were notable increases in teachers' use of technology as a communication tool and for the enhancement of their own professional productivity. Core teachers (as a whole) at about a fifth of schools reached a substantial level of Classroom Immersion. HLM analyses for individual students and their teachers showed that reading and mathematics teachers' reported levels of Classroom Immersion, in most cases, were statistically insignificant predictors of students' TAKS reading and mathematics achievement. Measurement issues, within classroom variability, and interdisciplinary teacher effects provide potential explanations for the unexpected results.

**Students' access to and use of laptops for learning within and outside of school generally fell short of substantial to full implementation.** Students at more than two-thirds of schools had just partial levels of Student Access and Use in the third year, whereas students at about a third of schools had only minimal access and use. 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. Year-to-year comparisons indicated that students' Laptop Access Days declined between the second and third project years. In contrast, students reported small increases in their use of laptops for Core-Content Learning and Home Learning.

**Larger schools and schools with a greater proportion of economically disadvantaged students had lower levels of implementation.** Overall trends showed that schools with larger student enrollments tended to have slightly lower implementation levels than schools with fewer students, and schools with higher percentages of economically disadvantaged students tended to have lower implementation levels. Technical support was a significant problem at larger schools, whereas collective teacher support for technology innovation was a significant issue for schools with greater proportions of disadvantaged students. Teachers at higher poverty schools also grew in technology proficiency at significantly lower rates, and student access to and use of technology decreased as the percentages of minority and economically disadvantaged students increased. In contrast, the schools' achievement context (percentage of students passing all TAKS tests), was positively associated with nearly all of the implementation indicators. Clearly, if students are to realize the full potential of laptops and technology resources, larger schools and schools serving disadvantaged student populations must have adequate supports for technology immersion in place to meet the specific needs of the school's teachers, students, and parents prior to implementing an immersion project.

# 1. Introduction

Historically, the piecemeal way in which most Texas schools introduced technology into the educational process has been an obstacle to the effective use of technology for teaching and learning (Texas Education Agency, 2006). Recognizing this limitation, the Technology Immersion Pilot (TIP), created by the Texas Legislature in 2003, set forth a vision for technology immersion in public schools. Senate Bill 396 called for the Texas Education Agency (TEA) to establish a pilot project to "immerse" schools in technology by providing a wireless mobile computing device for each teacher and student, technology-based learning resources, training for teachers to integrate technology into the classroom, and support for effective technology use. In response to this non-funded legislative mandate, the TEA has used more than $20 million in federal Title II, Part D monies to fund *technology immersion* projects for high-need middle schools through a competitive grant process. Concurrently, a research study, partially funded by a federal Evaluating State Educational Technology Programs grant, 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 for this four-year evaluation that began in the 2004-05 school year and will continue through 2007-08.

## Theory of Technology Immersion

The vision for educational technology endorsed by many educators, leaders, and policymakers has shifted in recent years 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 environments that enhance teaching and learning. Cognitive science and other research reveal that children learn more when they are engaged in meaningful, relevant, and intellectually stimulating work (Bransford, Brown, & Cocking, 2003; Newmann, Bryk, & Nagoaka, 2001). Many believe that technology can support such learning experiences and also enable students to develop competencies needed for the 21st century, such as digital literacy, inventive thinking, and effective communication (CEO Forum, 2001; Lempke, Couglin, Thadani, & Martin, 2003; Partnership for 21st Century Skills, 2006).

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

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

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

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

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

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

## Purpose of the Study

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). The evaluation also examines the relationships that exist among contextual conditions, technology immersion, intervening factors (school, teacher, and student), and student achievement. The research design is quasi-experimental with middle schools assigned to either treatment or control groups. This report concentrates on information gathered during the 2006-07 school year at 21 treatment and 21 control schools. Researchers answered the following questions:

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

## 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 researchers to estimate of the effects of technology immersion, which is the difference between the treatment and control groups. We also postulate 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 that an improved school environment for technology should then lead to teachers who have greater technology proficiency, 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, these improved school and classroom conditions should lead students to greater technology proficiency, more frequent classroom technology activities, more opportunities for peer collaboration, greater personal self-direction, and stronger engagement in school and learning. Student mediating variables presumably will contribute to increased academic performance as measured by standardized test scores. In the framework, links also are shown between student achievement and student, family, and school characteristics, which exert their own influence on learning. The research literature underpinning the framework is included in Appendix A.

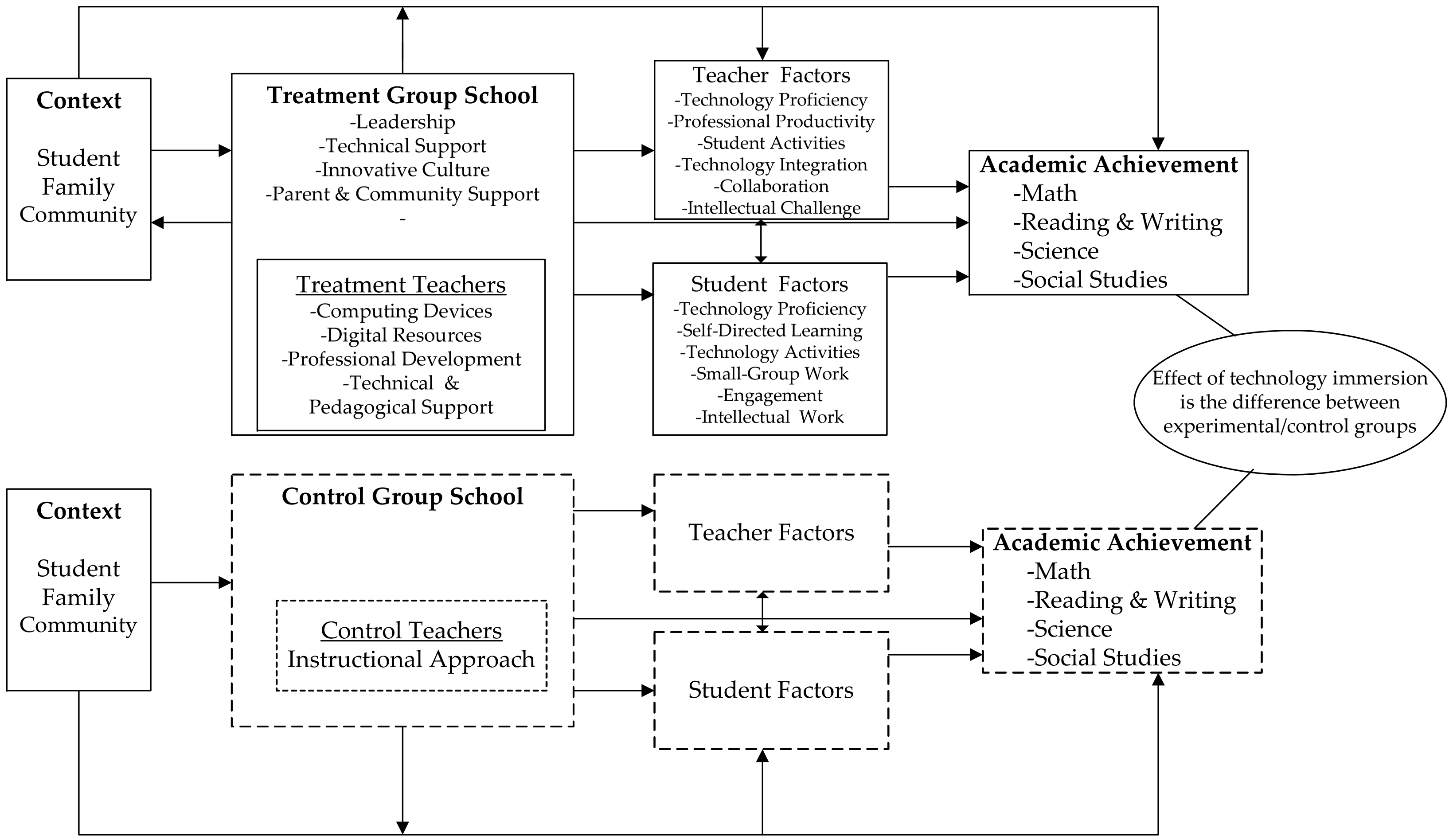

Figure 1.1. Theoretical Framework for Technology Immersion

## Organization of the Report

Data collection in the third project year (2006-07) involved a mix of qualitative and quantitative data sources. Researchers conducted site visits to each of the middle schools in fall 2004 and again in spring of 2005, 2006, and 2007. For this report, we concentrate on data gathered through observations in a sample of grades 6, 7, and 8 classrooms. Additional measures include annual online teacher surveys and student paper-and-pencil surveys. We also have gathered school and student data on a yearly basis from the Texas Public Education Information Management System (PEIMS), the Academic Excellence Indicator System (AEIS), as well as data on student disciplinary actions from schools.

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

- *Chapter 1, Introduction,* provides background on the technology immersion project as well as the study's theoretical framework. The chapter also establishes the purpose for the study and the research questions addressed.
- *Chapter 2, Methodology,* presents information on the evaluation design, characteristics of treatment and control schools, study limitations, study participants, data collection methods, and data analysis procedures.
- *Chapter 3, Technology Immersion—Third-Year Implementation,* describes progress toward implementation in the third year and compares second- and third-year implementation.
- *Chapter 4, Effects of Technology Immersion on Teachers and Teaching*, presents findings on the effects of immersion on teacher variables, including technology knowledge and skills, ideology, student classroom activities and peer collaboration, and the intellectual challenge of lessons.
- *Chapter 5, Effects of Technology Immersion on Students and Learning*, offers findings on the effects of immersion on mediating variables, including students' experiences with technology; their self-perceptions of technology proficiency, self-directed learning, and school satisfaction; and their engagement in school and learning.
- *Chapter 6, Effect of Technology Immersion on Student Achievement*, presents findings on the effects of technology immersion on academic achievement, as measured by TAKS reading, mathematics, writing, science, and social studies.
- *Chapter 7, Factors Associated with Implementation and Outcomes,* presents results for investigations of factors related to the implementation of technology immersion, and the associations between implementation and student academic achievement.
- *Chapter 8, 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. Interested districts and associated middle schools responded to a Request for Application (RFA) offered by the Texas Education Agency (TEA) to become Technology Immersion Pilot (TIP) schools. Applicants had to meet eligibility requirements for Title II, Part D funds (i.e., high-need due to children from families with incomes below the poverty line, schools identified for improvement, or schools with substantial need for technology). Twenty-two technology immersion schools, selected through the competitive grant process, were matched by researchers with 22 control schools on key characteristics, including size, regional location, demographics, and student achievement. Two middle schools from one district (one treatment and one control) were removed from analyses in the second year due to damage caused by Hurricane Rita. Thus, third-year results are for 21 treatment and 21 control schools. A re-analysis of baseline data for the new comparison groups revealed no statistically significant differences between school and student characteristics. Thus, the study’s research design 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 and rank ordered. Following the external review, researchers and agency staff reviewed proposals to ensure that applications met criteria established for technology immersion. Final selection of TIP schools involved the consideration of several factors, including proposal ratings, size, location, student diversity, and academic achievement. Decisions were influenced by the need for geographic distribution and the availability of comparable schools for the control group pool. Schools received grants to support the implementation of technology immersion for four school years.

### Control Sample

The selection of control campuses first involved the generation of a pool of grades 6 to 8 middle schools eligible to receive federal funds for participation in the study. As a next step, researchers identified middle schools that matched treatment campuses as nearly as possible on factors, including (a) district and campus size, (b) regional location, (c) the proportion of economically disadvantaged and minority students, (d) percentage of students passing all TAKS tests, and (e) the gaps between the percentage of White students and African American and Hispanic students passing TAKS (all tests). Selection involved the use of *SPSS*® statistical software procedures to establish parameters around each variable of interest and the creation of a computer-generated list of “best matches” for each treatment school. The final selection involved a review of the matched list by a team of six researchers to identify the optimal control school for each treatment school. Additional schools were selected as alternates in the case that a selected control site declined the invitation to participate in the study. This selection process yielded 22 control group schools including controls for 8 campuses that came from within the same districts as the treatment schools and controls for 14 campuses from closely matched single, middle school districts. For the first two evaluation years, each control school received $25,000 annually for study participation, with 25% of funds earmarked for professional development as required by Title II, Part D guidelines.

At the end of the second year, the TEA offered grants to control schools to begin planning for technology immersion. Of the 21 control schools included in analyses, 16 (76%) applied for and received TIP start-up grants. Grant guidelines allowed control schools to begin planning for technology immersion in the third year (2006-07); teachers could also receive laptops and instructional resources, and schools were required, as in previous years, to use 25% of funds for professional development. In the fourth year (2007-08), schools will provide laptops for their students, although the majority of schools plan to concentrate on single grade levels rather than the entire school. Control schools that declined immersion grants continued to receive $25,000 annually for study participation.

## Characteristics of Participating Schools

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

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 (Table 2.1). Likewise, results for student enrollment, mobility, and TAKS passing rates show no significant differences. Consequently, the treatment and control schools are sufficiently well matched on key demographic and academic performance measures. Additionally, both treatment and control groups include a comparable range of campus and district enrollments and schools from diverse regions.

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

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

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

Considering baseline statistics, the sample selection process and matching procedures appear to have produced a sample of schools with good internal validity, in that there are no large, statistically significant treatment-control differences. Still, the tendency for immersion schools to enroll somewhat higher percentages of minority, economically disadvantaged, and limited English proficient students could affect outcomes given known links between disadvantaged status and lower achievement (Sirin, 2005). Another threat to internal validity was introduced in the third project year when control schools began to implement elements of the treatment. As noted above, control schools began to plan for technology immersion in the third year, and most of the control teachers received new laptops and instructional resources. And, while teachers at control schools had opportunities for technology-related professional development during the first two project years, the emphasis intensified in the third year as schools purchased professional development services from vendors (Dell/Pearson and Apple) that focused on elements of technology immersion. Introducing portions of technology immersion in control schools could underestimate the magnitude of the treatment effect in the third year.

Another limitation of the study is external validity—the extent to which the results of an experiment can be generalized from the specific sample to the general population. Schools eligible to become part of the treatment group were limited to those serving 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, with 67% of sample students qualifying for federal free or reduced-price lunch compared to 51% for middle schools statewide. Sample schools include substantially more Hispanic and less White and African American students than state averages for middle schools. Overall, about 58% of sample students are Hispanic compared to about 37% of Texas middle school students. Conversely, the sample includes fewer African American students (7% vs. 14%) and White students (36% versus 46%) compared to the state averages. The sample schools also differ structurally from Texas middle schools as a whole. Middle schools in Texas, on average, enroll more students (667 vs. 402 in sample schools). Sample schools are located either in small or very small districts or large districts, whereas state middle schools are distributed across very small or small, mid-sized, and large districts. Differences between sample schools and the state almost certainly reflect funding restrictions (Title II, Part D) and the amount of available funds per grant. The maximum grant amount ($750,000) fell well short of the amount required to support one-to-one technology in larger middle schools.

## Participants

### Students

Four groups or cohorts of students are followed by the study, with Cohort 1 followed for four years, Cohort 2 for three years, Cohort 3 for two years, and Cohort 4 for one year (Table 2.2). Data collection in 2006-07 centered on Cohorts 1, 2, and 3. Cohort 1 (eighth graders) included a total of 5,449 students, with 2,586 students enrolled at treatment campuses and 2,863 at control campuses; Cohort 2 (seventh graders) included 5,526 students, with 2,644 at treatment campuses and 2,882 at control campuses; and Cohort 3 (sixth graders) included 5,437 students, with 2,597 students at treatment campuses and 2,840 at control campuses.

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

**Table 2.2. Student Cohorts by School Year and Grade**

| | 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 2.3 shows that about three-fourths of eighth graders (Cohort 1), seventh graders (Cohort 2), and sixth graders (Cohort 3) are economically disadvantaged. Comparison groups have similar proportions of disadvantaged and minority students, and female and male students. The main difference between groups is the greater proportion of limited English proficient (LEP) students in treatment schools (about 9 to 13 percent more). Treatment schools also have slightly higher percentages of economically disadvantaged and Hispanic students.

**Table 2.3. Demographic Characteristics of Students: 2006-07**

| | Enroll-ment | Eco Disadv. | Ethnicity | | | LEP | Gender | |
|---|---|---|---|---|---|---|---|---|
| | | | AA | Hispanic | White | | | |
| **Cohort 1** | | | | | | | | |
| Treatment | | | | | | | | |
| *N* | 2,586 | 1,959 | 151 | 1,881 | 527 | 587 | 1,257 | 1,329 |
| % | 47.5 | 75.8 | 5.8 | 72.7 | 20.4 | 22.7 | 48.6 | 51.4 |
| Control | | | | | | | | |
| *N* | 2,863 | 2,078 | 213 | 1,920 | 713 | 380 | 1,385 | 1,478 |
| % | 52.5 | 72.6 | 7.4 | 67.1 | 24.9 | 13.3 | 48.4 | 51.6 |
| **Cohort 2** | | | | | | | | |
| Treatment | | | | | | | | |
| *N* | 2,644 | 2,043 | 150 | 1,966 | 496 | 732 | 1,312 | 1,332 |
| % | 47.8 | 77.3 | 5.7 | 74.4 | 18.8 | 27.7 | 49.6 | 50.4 |
| Control | | | | | | | | |
| *N* | 2,882 | 2,106 | 234 | 1,963 | 666 | 415 | 1,400 | 1,482 |
| % | 52.2 | 73.1 | 8.1 | 68.1 | 23.1 | 14.4 | 48.6 | 51.4 |
| **Cohort 3** | | | | | | | | |
| Treatment | | | | | | | | |
| *N* | 2,597 | 2,050 | 128 | 1,961 | 496 | 775 | 1,257 | 1,340 |
| % | 47.8 | 78.9 | 4.9 | 75.5 | 19.1 | 29.8 | 48.4 | 51.6 |
| Control | | | | | | | | |
| *N* | 2,840 | 2,119 | 195 | 1,991 | 640 | 605 | 1,403 | 1,437 |
| % | 52.2 | 74.6 | 6.9 | 70.1 | 22.5 | 21.3 | 49.4 | 50.6 |

*Note.* Spring 2007 student database collected from 21 treatment and 21 control schools

## Teachers

During the 2006-07 school year, 1,253 teachers participated in the study, including 591 at treatment campuses and 662 at control campuses (Table 2.4). Teachers in comparison groups are remarkably similar in terms of gender, ethnicity, advanced degrees, and average teaching experience. The number of teachers declined in the second and third years due to the exclusion of two campuses.

**Table 2.4. Demographic Characteristics of Teachers by Year**

| | 2004-05 | | 2005-06 | | 2006-07 | |
|---|---|---|---|---|---|---|
| | Treatment *N=22* | Control *N=22* | Treatment *N=21* | Control *N=21* | Treatment *N=21* | Control *N=21* |
| Number of teachers | 622 | 682 | 604 | 653 | 591 | 662 |
| % Female | 65.4 | 68.8 | 63.4 | 68.3 | 66.5 | 69.2 |
| % Minority | 42.4 | 35.3 | 44.9 | 43.3 | 43.1 | 42.9 |
| % African American | 7.8 | 7.5 | 2.8 | 4.8 | 3.2 | 5.3 |
| % Hispanic | 32.2 | 26.3 | 40.4 | 37.3 | 39.9 | 37.6 |
| % White | 57.6 | 64.7 | 55.1 | 56.7 | 55.2 | 56.0 |
| % with no degree | 0.0 | 2.0 | 0.2 | 0.3 | 0.2 | 1.4 |
| % with advanced degree | 21.7 | 22.2 | 21.2 | 18.3 | 19.3 | 18.1 |
| Average years experience | 10.9 | 11.4 | 10.6 | 11.5 | 10.8 | 11.4 |

*Note.* The total number of teachers was 1,304 in 2004-05, 1,257 in 2005-06, and 1,253 in 2006-07.

## Data Collection

Data collection for the project began in August 2004. As Table 2.5 illustrates, researchers conducted site visits at each of the middle schools in fall 2004 and in spring of 2005, 2006, and 2007. 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, 2006, and 2007, individual middle schools submitted student-level data on disciplinary actions.

**Table 2.5. Time Frame for Data Collection by Year**

| | 2004-05 | | 2005-06 | | 2006-07 | |
|---|---|---|---|---|---|---|
| | Fall 2004 | Spring 2005 | Fall 2005 | Spring 2006 | Fall 2006 | Spring 2007 |
| Site visits (classroom observations) | X | X | | X | | X |
| Teacher Questionnaire (all teachers) | X | X | | X | | X |
| Teacher Questionnaire (new teachers) | | | X | | X | |
| Student Questionnaire and SLI (Cohort 1) | X | X | | X | | X |
| Student Questionnaire and SLI (Cohort 2) | | | X | X | X | X |
| Student Questionnaire and SLI (Cohort 3) | | | | | X | X |
| Texas Assessment of Knowledge/Skills (TAKS) | | X | | X | | X |
| Attendance | | X | | X | | X |
| Disciplinary actions | | X | | 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 and 2006-07. TAKS and attendance data were collected for spring 2003 through 2007. SLI = Style of Learning Inventory.

### Measures

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

#### *Teacher Questionnaire*

Immersion and control teachers completed an online technology survey in fall 2004 (September to October) and spring 2005 (April to May). Additionally, in fall 2005 and 2006 (September to October), teachers new to the schools completed the survey, and in spring 2006 and 2007 (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). In spring 2007, 1,208 teachers completed surveys (94% of all teachers, 94% of treatment, and 93% of control).

**School mediating variables.** Teachers responded to 33 items pertaining to their perceptions of school technology. They rated their strength of agreement with statements on a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Maximum likelihood factor analysis with Varimax rotation revealed five distinct factors, including Leadership (12 items), Classroom Technology Integration (4 items), Technical Support (5 items), Innovative Culture (4 items), and Parent and Community Support (2 items). Measures of internal consistency (Cronbach's alpha) for school-level factors ranged from 0.66 to 0.97.

**Teacher mediating variables.** Teacher surveys included measures of mediating variables, with items pertaining to teachers' perceptions of Technology Proficiency (27 items), Professional Productivity (17 items), Student Classroom Activities (17 items), and Collaboration (11 items related to teacher interactions with colleagues). Additionally, confirmatory factor analysis of items adapted from the Levels of Technology Implementation (LoTi) Questionnaire (Moersch, 2001) showed reasonable fit indices for a model having Technology Integration (10 items), Learner-Centered Instruction (4 items), and Resistance to Integration (3 items) as factors. Cronbach's alpha reliability coefficients for scales ranged from 0.70 to 0.98.

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

### *Student Surveys*

Students completed a paper-and-pencil questionnaire measuring their technology proficiency and use, and the *Style of Learning Inventory* (*SLI*), a measure of self-directed learning (i.e., self-generated behaviors oriented toward the attainment of learning goals). Cohort 1 students completed surveys as sixth graders in fall 2004 and spring 2005, as seventh graders in spring 2006, and as eighth graders in spring 2007. Cohort 2 students completed surveys as sixth graders in fall 2005 and spring 2006 and as seventh graders in spring 2007. Cohort 3 students (sixth graders) completed technology surveys in fall 2006 and spring 2007.

**Technology survey.** Survey items measured students' Technology Proficiency (22 items), Classroom Activities (12 items), Technical Problems (6 items), Small-Group Work (6 items), and School Satisfaction (6 items). Cronbach's alpha coefficients ranged from 0.77 to 0.94. As a measure of Technology Proficiency, students indicated how well they could use various technology applications on a 5-point scale: 1 (*I can do this not at all or barely),* 2 (*I can do this with some difficulty*), 3 (*I can do this fairly well*), 4 (*I can do this very well),* and 5 (*I can do this extremely well*). For measures of Classroom Activities, Technical Problems, and Small-Group Work, students used a 5-point scale to rate the frequency of activities or interactions: 1 (*never*), 2 (*rarely–e.g., a few times a year),* 3 (*sometimes–e.g.,* *once or twice a month)*, 4 (*often*–e.g., *once or twice a week)*, and 5 (*almost daily*). Students rated school satisfaction items on a 5-point agreement scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*).

Technology survey response rates for students are summarized in Table 2.6. Response rates were in the 80% to 91% range from fall 2004 through spring 2007. In each time period, there were only small differences in response rates between cohorts and comparison groups. Note that in spring 2007 response rates were slightly reduced because surveys were not administered at three campuses, two treatment and one control school.

**Table 2.6. Student Technology Survey Response Rates: 2004-05, 2005-06, and 2006-07**

| | Fall[a] | | Spring 2005 | | Spring 2006 | | Spring 2007 | |
|---|---|---|---|---|---|---|---|---|
| | *N* | *%* | *N* | *%* | *N* | *%* | *N* | *%* |
| **Cohort 1** | | | | | | | | |
| Treatment | 2,319 | 90 | 2,053 | 80 | 2,291 | 87 | 2,168 | 84 |
| Control | 2,505 | 84 | 2,485 | 83 | 2,544 | 87 | 2,473 | 86 |
| All | 4,824 | 87 | 4,538 | 82 | 4,835 | 87 | 4,641 | 85 |
| **Cohort 2** | | | | | | | | |
| Treatment | 2,209 | 84 | -- | -- | 2,379 | 89 | 2,228 | 84 |
| Control | 2,405 | 86 | -- | -- | 2,452 | 87 | 2,363 | 82 |
| All | 4,614 | 85 | -- | -- | 4,831 | 88 | 4,591 | 83 |
| **Cohort 3** | | | | | | | | |
| Treatment | 2,233 | 86 | -- | -- | -- | -- | 2,220 | 85 |
| Control | 2,584 | 91 | -- | -- | -- | -- | 2,464 | 87 |
| All | 4,817 | 89 | -- | -- | -- | -- | 4,684 | 86 |

[a] Students completed surveys as sixth graders in fall 2004, 2005, and 2006.

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

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

Students rated statements regarding their personal self-direction on a 7-point scale, ranging from 1 (*completely false)* to 7 (*completely true)*. Confirmatory factor analysis of fall 2004 *SLI* data revealed low convergent validity of the scales and groupings and no discriminant validity. In addition, the scales and groupings were not internally consistent ($\alpha = 0.18$ to 0.52). Because of these findings, analyses were limited to the *SLI* total score ($\alpha = 0.89$).

Table 2.7 summarizes *SLI* response rates. Response rates ranged from 71% to 89% across time periods. With the exception of the spring 2005 *SLI* administration, there were only small differences in response rates between cohorts or comparison groups.

**Table 2.7. Style of Learning Inventory Response Rates: 2004-05, 2005-06, and 2006-07**

| | Fall[a] | | Spring 2005 | | Spring 2006 | | Spring 2007 | |
|---|---|---|---|---|---|---|---|---|
| | *N* | *%* | *N* | *%* | *N* | *%* | *N* | *%* |
| **Cohort 1** | | | | | | | | |
| Treatment | 2,142 | 83 | 2,174 | 85 | 2,116 | 80 | 2,152 | 83 |
| Control | 2,442 | 82 | 2,120 | 71 | 2,387 | 81 | 2,472 | 86 |
| All | 4,584 | 82 | 4,294 | 77 | 4,503 | 81 | 4,624 | 85 |
| **Cohort 2** | | | | | | | | |
| Treatment | 2,115 | 80 | -- | -- | 2,198 | 82 | 2,201 | 83 |
| Control | 2,265 | 81 | -- | -- | 2,228 | 79 | 2,368 | 82 |
| All | 4,380 | 80 | -- | -- | 4,426 | 80 | 4,569 | 83 |
| **Cohort 3** | | | | | | | | |
| Treatment | 2,173 | 84 | -- | -- | -- | -- | 2,209 | 85 |
| Control | 2,534 | 89 | -- | -- | -- | -- | 2,434 | 86 |
| All | 4,707 | 87 | -- | -- | -- | -- | 4,643 | 85 |

[a] Students completed the Style of Learning Inventory as sixth graders in fall 2004, 2005, and 2006.

### *Observation of Teaching and Learning*

Researchers have conducted classroom observations for teachers who instructed Cohorts 1, 2, and 3 students. In fall 2004 and spring 2005, we observed in a sample of sixth-grade, core-subject classrooms (reading/English language arts, mathematics, science, and social studies). In spring 2006, we observed a sample of classrooms including sixth-grade teachers (Cohort 2 students) and seventh-grade teachers (Cohort 1 students). In spring 2007, we observed a sample of classrooms including sixth-grade teachers (Cohort 3 students), seventh-grade teachers (Cohort 2 students), and eighth-grade teachers (Cohort 1 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 standards measuring the intellectual quality of classroom instruction on a 5-point scale: Higher Order Thinking, Disciplined Inquiry, Substantive Conversation, and Value Beyond School. An aggregate score across three of the standards was used as an overall measure of the Intellectual Challenge of instruction. We excluded the Substantive Conversation standard because ratings were biased by teachers' classroom organization. Classes with teacher-directed instruction typically provided more public conversations, and thus, better opportunities to document the nature of conversational exchanges.

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

**Training procedures.** Prior to site visits in fall 2004 and spring of 2005, 2006, and 2007, researchers participated in one- or two-day training events. Training activities informed data collectors about the research design, aspects of technology immersion, data collection protocols, effective interview and focus group techniques, and classroom observation procedures. Approximately half of each training event was devoted to the establishment of inter-rater agreement on the OTL form. During observation training, raters first reviewed background information and individual item and code definitions in the OTL manual. Raters next viewed a video in which a classroom teacher used technology as part of a lesson. The trainer stopped raters at 10-minute intervals to record ratings, discuss the extent of agreement or disagreement, and resolve misunderstandings. This process was repeated for an additional classroom video.

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

**Inter-rater agreement.** Inter-rater agreement on the rating scales for the Intellectual Challenge standards (Higher-Order Thinking, Disciplined Inquiry, Substantive Conversation, and Value Beyond School) was established by calculating the percentage of time observers agreed on ratings from paired observations. Analyses of observations from fall 2004 indicated 78% inter-rater agreement. Agreement reached 98% when scale categories were allowed to vary by one scale point (on the 5-point scale). Inter-rater agreement declined somewhat in spring of 2005, 2006, and 2007. Exact agreement was 63%, 62%, and 62%, respectively, and 89%, 93%, and 96% when ratings varied by one scale point.

**Reliability of scores.** Statistics for inter-rater agreement indicated that raters may have had somewhat different standards for assigning scores, so we needed to adjust statistically for the differences in the severity of raters. An overall measure of Intellectual Challenge for each teacher was constructed using MFRM. The quality of instruction measure is an aggregate score across three standards (Higher Order Thinking, Disciplined Inquiry, and Value Beyond School). The measure is adjusted for the relative difficulty of each standard and the relative severity (or leniency) of each observer. MFRM analysis produces several fit statistics that can be used to measure each observer's intrarater reliability or internal consistency. One of these, observer infit, weights each standardized residual by its variance and is more sensitive to unexpected patterns of small residuals. A second statistic, observer outfit, is an unweighted mean-square residual sensitive to outlying residuals (Linacre, 2004).

There is no fixed rule for setting upper and lower limits for theses fit statistics. "Misfitting" raters have been defined as having either a mean-square infit or outfit statistic greater than 1.5 (Lunz, Wright, & Linacre, 1990), or the range has been from 0.5 to 3.0 (Myford & Wolfe, 2000). We define a "misfitting" observer as one with either a mean-square infit or outfit statistic less than 0.5 or greater than 1.5. This defines “misfit” as less than 50% of the variance in ratings than is modeled (a muted pattern) and more than 50% of the variance than is modeled (a noisy pattern). Observation data in fall 2004, spring 2005, spring 2006, and spring 2007, respectively, resulted in observer infit values from 0.61 to 1.34, 0.61 to 1.34, 0.43 to 1.59, and 0.58 to 1.14, and observer outfit values from 0.62 to 1.20, 0.62 to 1.20, 0.40 to 1.67, and 0.66 to 1.17. 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. No unusual rating patterns appeared to be present in the spring 2006 classroom observation data, with only slightly unpredicted or overly predictable ratings (Linacre, 1995).

### *Texas Assessment of Knowledge and Skills (TAKS)*

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

Table 2.8 shows the TAKS completion schedule for Cohorts 1, 2, and 3 students. Students complete TAKS reading and mathematics assessments annually, so all student cohorts have pretest and posttest measures. Additionally, Cohort 1 students completed TAKS science in 2004 (5th grade) and 2007 (8th grade), and TAKS social studies in 2007. Cohort 2 students completed the TAKS writing assessment in 2004 (4th grade) and 2007 (7th grade).

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

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

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

At grades 6, 7, and 8, TAKS reading measures four objectives: understanding of culturally diverse written texts, knowledge of literary elements, use of strategies to analyze written texts, and application of critical-thinking skills. TAKS mathematics at grades 6, 7, and 8 measures six objectives: numbers, operations, and quantitative reasoning; patterns, relationships, and algebraic reasoning; geometry and spatial reasoning; concepts and uses of measurement; probability and statistics; and mathematical processes and tools used in problem solving.

At grade 7, TAKS writing measures six objectives: given a context, produce an effective composition for a specific purpose; demonstrate a command of conventions of spelling, capitalization, punctuation, grammar, usage, and sentence structure; recognize appropriate organization of ideas in written text; recognize correct and effective sentence construction in written text; recognize standard usage and appropriate word choice in written text; proofread for correct punctuation, capitalization, and spelling in a written text. At grade 8, TAKS science measures five objectives: nature of science; living systems and the

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

environment; structures and properties of matter; motion, forces, and energy, and earth and space systems. Grade 8 TAKS social studies measures five objectives: history, geography, economics and social influences, political influences, and social studies skills.

### *School Attendance and Disciplinary Actions*

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

# 3. Technology Immersion—Third-Year Implementation

Researchers have investigated the implementation of *technology immersion* across three project years. Second-year findings showed that many of the 21 treatment schools continued to have difficulty implementing the prescribed components of the technology immersion model. Implementation supports for immersion generally did not meet full implementation standards, and accordingly, overall implementation at the classroom and student levels was low. Still, implementation levels varied by campus and about a third of schools reached levels that more nearly met substantial to full immersion standards. Given known associations between implementation quality and outcomes (e.g., Berman & McLaughlin, 1978; Borman, 2005; Borman, Hewes, Overman, & Brown, 2003; Datnow, Borman, & Stringfield, 2000), we continued to monitor schools' progress in the third year. This chapter begins with a description of technology immersion and the use of technology immersion packages as a means to operationally define the treatment and ensure more consistent implementation across sites. Next, we describe our approach to measuring implementation. Finally, findings are presented on the fidelity of third-year implementation at the treatment schools, and comparisons are made between implementation for the second (2005-06) and third (2006-07) project years.

## Defining Technology Immersion

To promote consistent interpretation of the technology immersion model and comparability of implementation across schools, the Texas Education Agency (TEA) issued a Request for Qualifications (RFQ) that allowed commercial vendors to apply to become providers of technology immersion packages (TEA, 2003). State statute provided a general description of technology immersion, but the concept and its component parts were defined operationally to foster uniformity. Vendors had to include six components in their plan:

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

Through an expert review process, the TEA selected three lead vendors as providers of technology immersion packages (Dell Computer Inc., Apple Computer Inc., and Region 1 Education Service Center [ESC]). Package costs, which ranged from about $1,100 to $1,600 per student, varied according to the numbers of students and teachers, the type of laptop computer, and the vendor provider. Of the 21 immersion sites studied in the second and third years, 5 middle schools selected the Apple package, 15 selected the Dell package, and 1 school selected the Region 1 ESC package (Dell computer).
Table 3.1 provides an overview of the basic components within each package and the individual vendors that provided various products. All vendors offered a wireless laptop as the mobile computing device

(Apple or Dell), and all laptops had a suite of productivity tools (either *AppleWorks* or *Microsoft Office*). Dell computers also had a web-based portal (*eChalk*) to applications and resources.

**Table 3.1. Technology Immersion Packages**

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

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

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

## Measuring Implementation Fidelity

Implementation is measured as the fidelity with which technology immersion *components* and related *elements* attain an envisioned “ideal.” This approach 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. The seven immersion components include five supports for implementation (Leadership, Teacher Support, Parent and Community Support, Technical Support, and Professional Development) and two components related to teacher and student implementation outcomes (Classroom Immersion and Student Access and Use). Consistent with second-year procedures, we used a two-part measurement approach in the third year. First, we used indicators to describe each campus’ progress on a 4-stage 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). $Z$ scores allowed the calculation of composite scores across indicators with varying scales and standard deviations.

## Implementation Indicators

Both the immersion standard scores and implementation indices are derived from values for the seven components and their related elements. Scores come from spring 2007 surveys of teachers (*N* = 619, including 371 core-subject teachers) and students (*N*=6,634) at treatment schools. Table 3.2 provides descriptions of the technology immersion indicators. Appendix D provides additional technical detail on the measurement of implementation fidelity and the scoring rubrics that describe the four levels of immersion.

**Table 3.2. Description of Implementation Indicators for Technology Immersion**

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

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

## Computing Implementation Scores

### Scores for Immersion Standards

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

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

### Scores for Implementation Indices

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

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

## Implementation of Technology Immersion

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

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

[2] Variables were standardized as z scores from their original scale or continuous variable values. The use of *z scores* rather than the *immersion standard scores* was necessary in order to aggregate data across variables that had widely varying standard deviations.

indices (z scores) to provide an overall measure of technology immersion (Implementation Index) and to compare the relative level of implementation for components across campuses.

## 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 one component gauges the extent of teachers' Classroom Immersion and another component measures Student Access and Use (of technology). Figure 3.1 displays the mean implementation scores by component and project year.

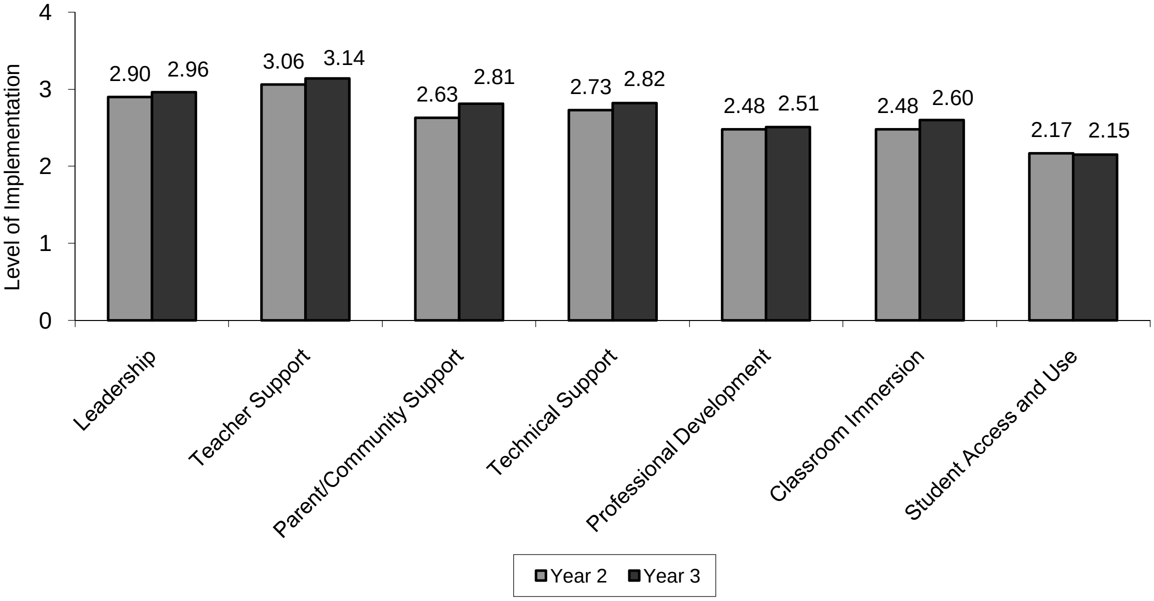

**Figure 3.1. Mean level of implementation (measured on a 0 to 4 scale) for seven Technology Immersion components (N=21 middle schools) by year.**[3]

Mean immersion standard scores showed small increases between the second implementation year (2005-06) and the third year (2006-07) for all components except Student Access and Use. Despite progress, however, third-year mean scores ranging from 2.51 (Professional Development) to 3.14 (Teacher Support) showed that supports for technology immersion from school administrators, teachers, the community, technical staff, and professional development providers did not meet *full* implementation standards (mean score of 3.50 to 4.00). And, consistent with the second year, teachers, on average, reported only *partial* levels of Classroom Immersion ($M$ = 2.60) in the third year, and students, as a whole, reported *partial* levels of technology access and use ($M$ = 2.15). Results for individual components are discussed in detail below.

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[3] Standards-based scores for Professional Development, Classroom Immersion, and Student Access and Use are averages across elements of these components. These scores serve descriptive purposes. Composite *z* scores are used in statistical analyses. Student Access and Use data are for 19 middle schools.

### *Level of Principal, Teacher, and Parent/Community Support*

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

**Leadership**. Administrators play key roles in setting the direction for technology immersion, providing resources, and building the capacity of staff. Thus, teachers at each school have been asked every year to rate the quality of administrative leadership. Administrators demonstrated leadership through behaviors such as involving staff in decisions, setting clear expectations for technology use, encouraging and participating in professional development events, and providing resources and support. Results in Figure 3.2 show that administrative leadership was stable across the second and third implementation years. Teachers at nearly half of campuses reported substantial levels of leadership, with mean scores across years (3.19 and 3.25, respectively) indicating that they either *agreed* or *strongly agreed* that administrators provided technology-related leadership. Teachers in an additional half of schools reported partial levels of administrative support (*M* = 2.64 and 2.69, respectively). No schools had the level of leadership required for full immersion.

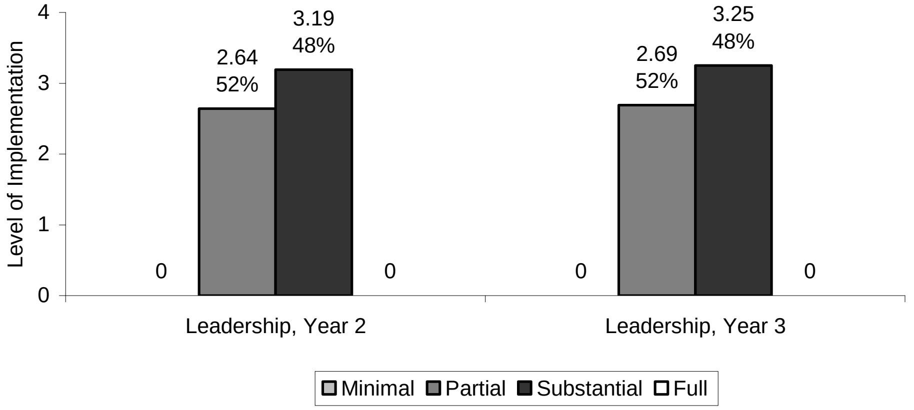

**Figure 3.2. Level of implementation (measured on a 0 to 4 scale) for Leadership, by the *mean implementation score* and *percentage of schools* at each implementation level for years 2 and 3.**

**Teacher Support.** Teacher "buy-in" for technology immersion is critically important because students' school experiences with technology are largely dictated by their teachers. Thus, it is noteworthy that teachers reported increased levels of support for technology immersion across years (Figure 3.3). In the third year, teachers at about a tenth of campuses reported a full level of support (*M* = 3.66). That is, teachers at these schools *strongly agreed* that they shared an understanding about technology use for student learning, were continually learning and seeking new ideas, were not afraid to learn about and use new technologies, and were supportive of integration efforts. Teachers at nearly two-thirds of schools reported a substantial level of support for technology innovation (*M* = 3.20). In contrast, teachers at about a quarter of campuses reported just partial levels of support (*M* = 2.83).

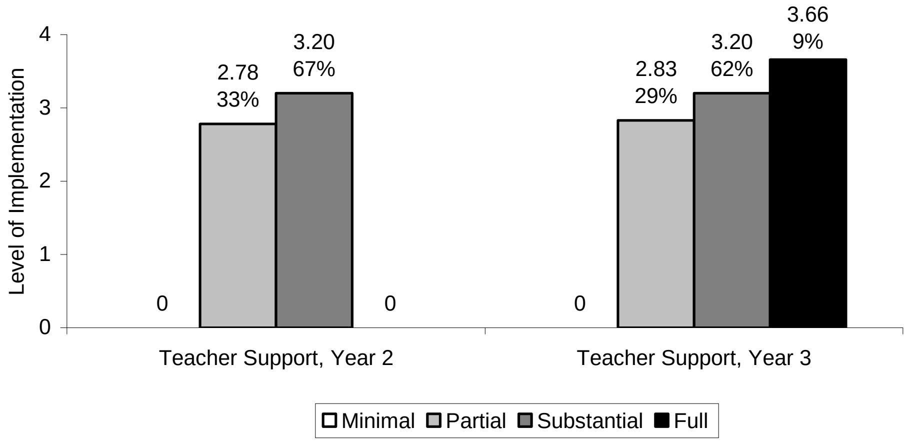

**Figure 3.3. Level of implementation (measured on a 0 to 4 scale) for Teacher Support, by the *mean implementation score* and *percentage of schools* at each implementation level for years 2 and 3.**

**Parent and Community Support.** Since parents must share responsibility for an expensive laptop computer with their child or children, their understanding of and support for technology immersion is imperative. Additionally, the enthusiastic support of community members, including elected members of the local school board and business people, may influence implementation through mechanisms such as the adoption of supportive policies, provision of resources, or promotion of positive public relations. Given the importance of parent and community support, teachers' increased perceptions of such support across years were important (Figure 3.4). In the third year, teachers at more than one-third of schools reported substantial levels of parent and community support (*M* = 3.24), with teachers generally agreeing that parents and the surrounding community supported their efforts with technology. Although teachers at almost two-thirds of schools reported just partial levels of parent and community support (*M* = 2.55), this represented an improvement over the second year when teachers at three-quarters of schools reported only minimal to partial levels of support.

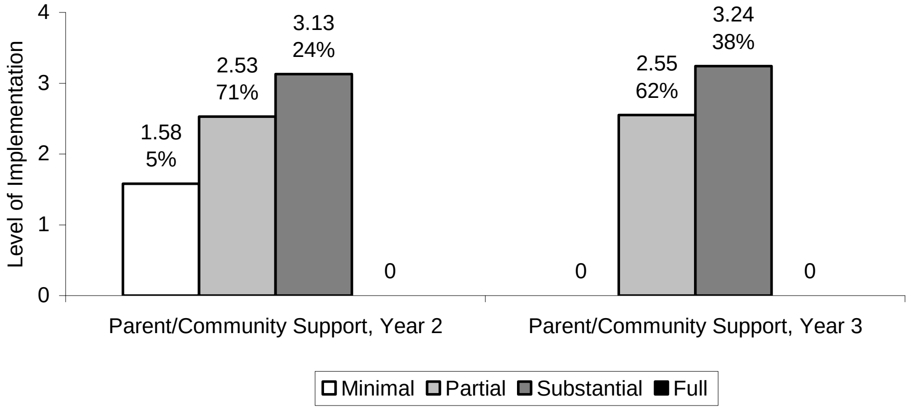

**Figure 3.4. Level of implementation (measured on a 0 to 4 scale) for Parent and Community Support, by the *mean implementation score* and *percentage of schools* at each implementation level for years 2 and 3.**

### *Level of Technical and Pedagogical Support*

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

**Technical Support.** Technical support for immersion should be provided by vendor technicians as well as district and campus staff who assist with implementation and offer timely support when technical problems arise. Similar to other support mechanisms described above, the level of technical support improved between the second and third project years (see Figure 3.5). Although teachers at more than a fourth of schools reported substantial levels of technical support in the third year (*M* = 3.17), teachers at nearly three-fourths of schools reported just a partial level of technical support (*M* = 2.68). Teachers at schools with partial implementation 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. Findings as a whole suggested that technical problems continued to challenge many teachers in the third year.

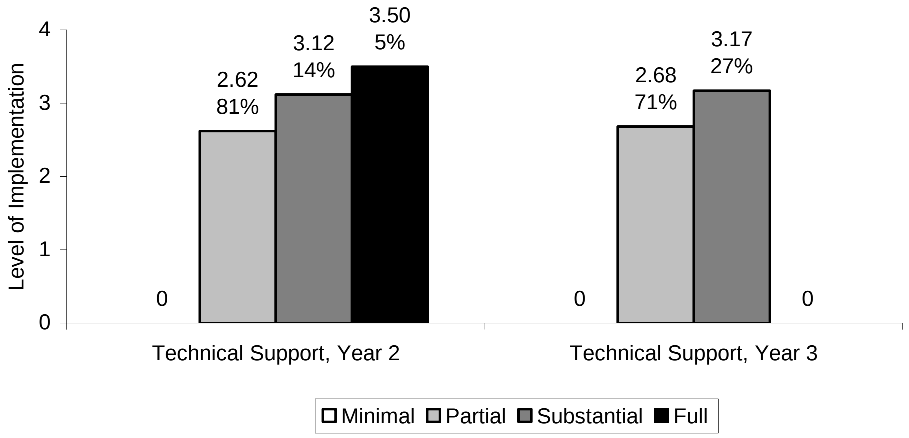

**Figure 3.5. Level of implementation (measured on a 0 to 4 scale) for Technical Support, by the *mean implementation score* and *percentage of schools* at each implementation level for years 2 and 3.**

**Professional Development**. Each of the technology immersion packages included a professional development component designed to support all educators on an implementing campus. The immersion model requires professional development that instructs teachers 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). Although professional development providers are obligated to support all teachers, our implementation measure concentrates on core-subject teachers because of their close association with measured student academic outcomes. Year-to-year comparisons displayed in Figure 3.6 for the composite Professional Development indicator (mean score for the standards-based elements) show there was little difference in the levels of implementation between the second and third years. The majority of campuses had minimal to partial levels of implementation for professional development across years 2 and 3. About a fifth of campuses achieved a substantial level of professional development in the third year (*M* = 3.09).

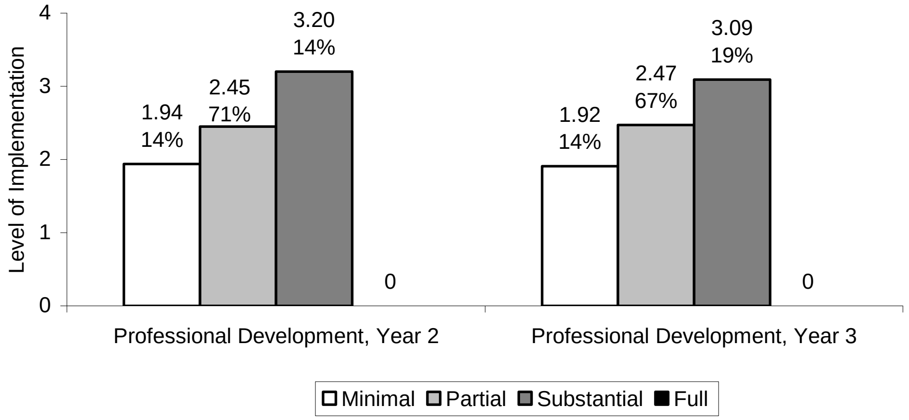

**Figure 3.6. Level of implementation (measured on a 0 to 4 scale) for Professional Development, by the *mean implementation score* and *percentage of schools* at each implementation level for years 2 and 3.**

Figure 3.7 compares the implementation levels for each of the elements that contributed to the composite Professional Development measures. Mean immersion standard scores at the partial implementation level across years indicate that core teachers did not receive either the targeted amount or type of professional development.

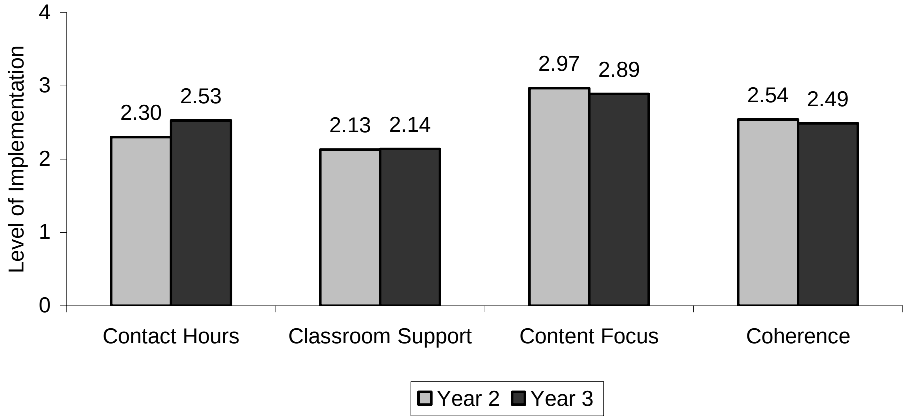

**Figure 3.7. Level of Implementation (measured on a 0 to 4 scale) for elements of the Professional Development component (Contact Hours, Classroom Support, Content Focus, and Coherence) by *mean implementation score* and year.**

First, teachers reported receiving less than the prescribed number of hours of technology-related professional development for each implementation year (estimated to be about 40 to 56 hours per year). Mean implementation scores (2.30 and 2.53) indicated that teachers, on average, participated in 30 hours or less of technology-related professional development each year. Additionally, teachers reported that they received just partial levels of classroom support for technology immersion. Mean scores (2.13 and 2.14 across years) 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).

Core-subject teachers who participated in technology-related professional development also expressed uncertainty about the extent to which activities supported their curricular and instructional goals.

Teachers, on average, reported that the content of professional development placed a *minor* emphasis on curriculum, instructional methods, and lesson development in core areas (mean scores of 2.97 and 2.89 reflect partial implementation). Additionally, teachers as a whole 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' mean ratings across years (2.54 and 2.49) indicated that professional development was coherent *to a minimal extent* (partial implementation).

### *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. Teachers' composite level of Classroom Immersion across project years indicates that teachers at a few schools made progress in creating technology-immersed classrooms (Figure 3.8). Teachers at about a tenth of schools had a substantial level of classroom immersion in the third year (*M* =3.09). In contrast, teachers at the majority of schools reported only partial levels of Classroom Immersion in both the second (*M* = 2.45) and third project years (*M* =2.47).

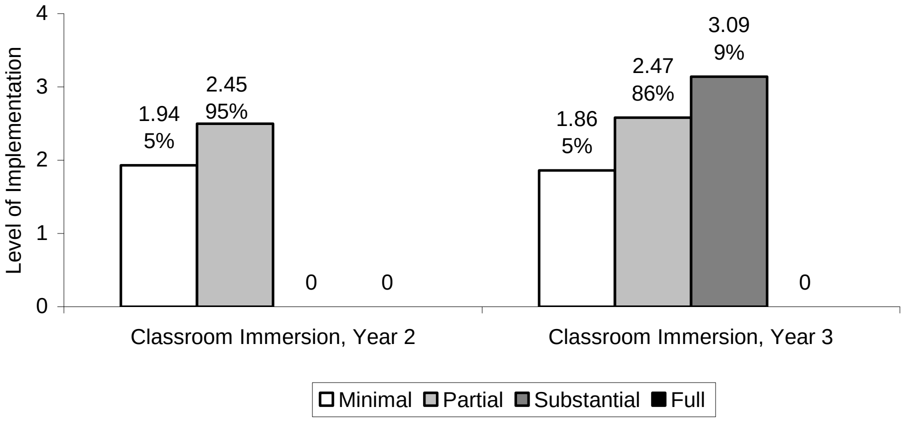

**Figure 3.8. Level of implementation (measured on a 0 to 4 scale) for the Classroom Immersion, by the *mean implementation score*, *percentage of schools* at each implementation level, and year.**

Figure 3.9 illustrates teachers' level of implementation relative to five elements of Classroom Immersion: Technology Integration, Learner-Centered Instruction, Student Classroom Activities (with technology), Communication, and Professional Productivity. On average, teachers reported partial levels of implementation for the elements of Classroom Immersion. However, for each element, teachers reported slightly stronger implementation in the third year. The largest increases were for teachers' ideological affiliations with Technology Integration and Learner-Centered Instruction, whereas the smallest change involved Student Activities with technology in classrooms. Thus, teachers became somewhat more positive about technology integration and constructivist methods but changed beliefs did not necessarily increase the frequency of classroom activities. On the other hand, teachers reported notable increases in the third year relative to their use of technology as a communication tool and for the enhancement of their professional productivity.

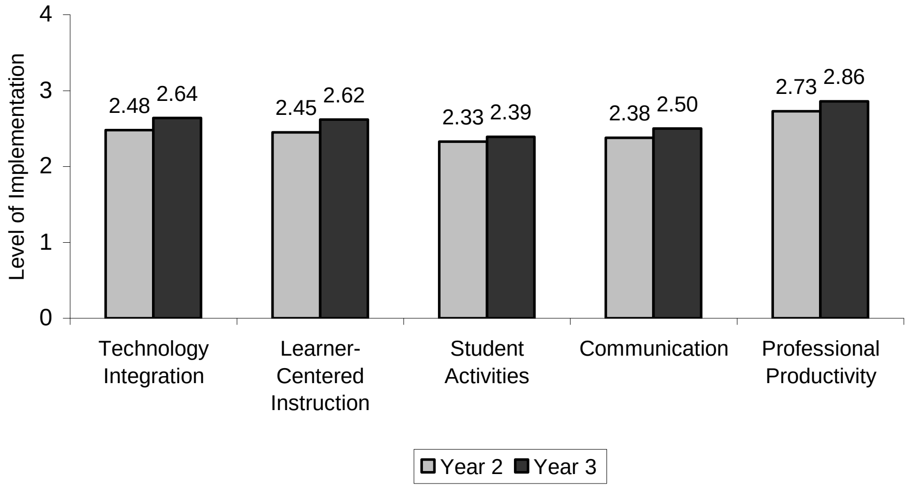

**Figure 3.9. Level of Implementation (measured on a 0 to 4 scale) for elements of Classroom Immersion (Technology Integration, Learner-Centered Instruction, Student Activities, Communication, and Professional Productivity) by *mean implementation score* and year.**

### *Level of Student Technology Access and Use*

The transformation of classroom experiences is a vital part of technology immersion, but the model also aims for students to have on-demand technology access both within and outside of school that allows them to become more independent and self-determined learners. Overall, data reported by students indicated that Student Access and Use remained relatively stable across the second and third years (Figure 3.10). Students at more than two-thirds of schools had partial access and use (mean implementation levels of 2.38 and 2.35 across years), whereas students at about a third of schools had minimal access and use (mean implementation levels of 1.60 and 1.74, respectively).

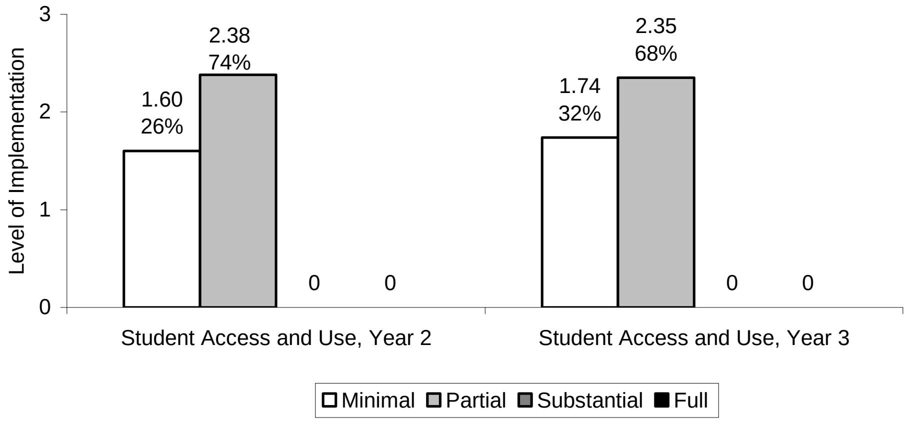

**Figure 3.10. Level of implementation (measured on a 0 to 4 scale) for the Student Access and Use, by the *mean implementation score* and *percentage of schools* at each implementation level for years 2 and 3.**

Figure 3.11 shows the average level of implementation for three elements of Student Access and Use: Laptop Access Days, Core-Content Learning, and Home Learning. First, in a fully immersed school, all students should have access to their wireless laptops and resources nearly the entire school year (about 170 to 180 days). Schools as a whole, however, had difficulty keeping laptops in the hands of students.

Year-to-year comparisons indicated that the mean implementation level for Laptop Access Days declined between the second and third years (from 2.69 to 2.50). Thus, students, on average, had laptops for a smaller number of days in the third year. Partial levels of implementation indicate that student access days typically varied at schools to a *large extent* (from 100 to 176 days per student). However, Laptop Access Days also varied widely across schools. In the third year, students at 16% of schools reported either substantial or full laptop access. In contrast, students at 63% of schools reported partial access, and students at 21% of schools reported minimal laptop access.

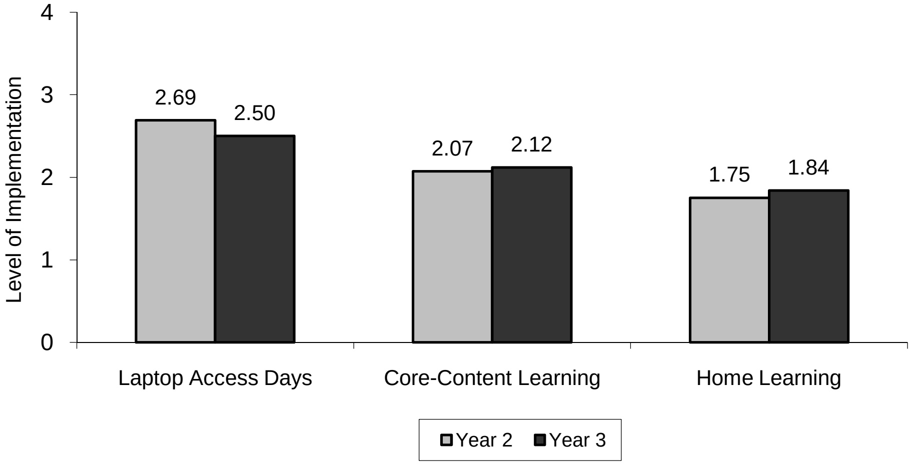

**Figure 3.11. Level of Implementation (measured on a 0 to 4 scale) for elements of Student Access and Use (Laptop Access Days, Core-Content Learning, and Home Learning) by *mean implementation score* and year.**

Students also estimated how often they used their laptops in their English/language arts, mathematics, science, and social studies classes and for learning at home. In contrast to Laptop Access Days, there were small increases in the third year for both Core-Content Learning and Home Learning. Still, students as a whole reported just a partial level of implementation across years for Core-Content Learning ($M$ = 2.07 and 2.12), with laptops typically used *sometimes* (once or twice a month) to *often* (once or twice a week) in classrooms. Students, on average, used their laptop even less frequently for learning outside of school. Students reported a minimal level of laptop use for home learning in both the second and third years ($M$ = 1.75 and 1.84). Thus, students as a whole used their laptops outside of school for homework and learning either *not at all* or *to a trivial extent*.

Overall, students' opportunities to use their laptops both within classrooms and outside of school were affected by the number of days that students actually had their laptops. In some schools, students' laptop access days were drastically reduced by factors such as time for repairs, technical issues, disciplinary infractions, and parent resistance. Students in other schools, contrary to the tenets of technology immersion, were not allowed to take their laptops home, or their home use was restricted in some way (e.g., laptops could only be used for special assignments).

In sum, overall results for the implementation of technology immersion as measured by standards-based scores suggest that the levels of support for implementation increased to some extent between the second and third years. Similarly, teachers' reported a slightly increased level of Classroom Immersion. In contrast, the level of Student Access and Use was relatively stable across years. Findings for standards-based scores also show that the level of implementation varied by campus. By the end of the third year, none of the middle schools achieved *full immersion*. Evidence suggests that a few campuses reached *substantial immersion*, whereas the majority of schools achieved only *minimal* to *partial immersion*.

## Implementation Indices

To further illustrate each school's level of immersion in the third year, Table 3.3 presents the composite campus Implementation Index (*z* score) alongside implementation indices (*z* scores) for each of the seven components. Z scores have a mean of 0 and a standard deviation of 1.0. Thus, the campus score indicates how many standard deviations from the mean a score lies. Schools with scores above 0 have higher values on the components of technology immersion, whereas schools with index values below 0 show less evidence of the immersion. The Implementation Index is an average score for the Support Index, Classroom Immersion Index, and Student Access and Use Index.[4]

**Table 3.3. Third-Year Implementation of Technology Immersion**

| | Support Index | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 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 | 1.29 | 1.82 | 1.17 | 0.94 | 1.79 | 1.92 | 0.83 | **1.89** |
| MS 2 | 1.59 | 2.09 | 1.40 | 1.78 | 1.72 | 0.24 | 1.38 | **1.58** |
| MS 3 | 0.22 | 0.12 | -0.75 | 0.39 | 0.85 | 1.66 | 1.39 | **1.35** |
| MS 4 | 0.97 | 0.75 | 0.90 | 0.47 | 0.27 | 0.78 | 0.43 | **0.87** |
| MS 5 | 0.92 | 0.62 | 0.97 | -0.03 | 0.93 | 0.63 | 0.22 | **0.72** |
| MS 6 | 1.02 | 0.98 | 0.46 | 0.96 | -0.62 | -0.42 | 0.90 | **0.50** |
| MS 7 | 0.88 | 0.41 | 0.34 | 0.42 | 1.03 | 1.13 | -0.77 | **0.49** |
| MS 8 | 1.05 | 0.71 | -0.13 | -0.29 | -0.37 | -0.26 | -0.04 | **0.20** |
| MS 9 | 0.60 | 0.21 | 0.23 | -1.56 | 0.63 | 1.03 | -0.90 | **0.08** |
| MS 10 | -1.64 | -0.99 | -0.46 | 0.17 | -1.01 | -0.42 | 1.19 | **-0.07** |
| MS 11 | 0.00 | 0.13 | 0.58 | -0.26 | 0.75 | -0.46 | -0.46 | **-0.25** |
| MS 12 | -0.17 | -0.28 | -0.90 | 0.71 | -0.25 | -0.14 | -0.36 | **-0.29** |
| MS 13 | -0.61 | -1.41 | -0.51 | -1.61 | -0.78 | -1.09 | 0.91 | **-0.58** |
| MS 14 | -1.29 | -0.41 | -1.55 | -0.86 | -1.25 | -0.45 | 0.38 | **-0.58** |
| MS 15 | -0.69 | 0.82 | 1.38 | 0.94 | -1.33 | -2.40 | 0.53 | **-0.66** |
| MS 16 | -0.37 | -0.96 | -1.11 | -1.66 | 0.39 | -0.31 | -1.65 | **-1.20** |
| MS 17 | -1.93 | -1.41 | -0.99 | -1.45 | -0.16 | -0.50 | -1.03 | **-1.25** |
| MS 18 | -0.59 | -0.52 | -1.68 | -0.49 | -0.63 | -0.90 | -1.19 | **-1.27** |
| MS 19 | -0.85 | -1.08 | -0.89 | -0.13 | -1.80 | -0.84 | -1.71 | **-1.55** |
| MS 20 | -0.66 | -0.52 | 1.48 | 0.15 | 0.52 | 0.61 | -- | **--**[a] |
| MS 21 | 0.25 | -1.08 | 0.09 | 1.41 | -0.66 | -0.33 | -- | **--**[a] |

*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.

[a] School did not submit spring 2007 student surveys.

Despite some variations in component scores, middle schools with higher values on the Implementation Index tended to have component scores that indicated a stronger presence of the immersion attributes such as administrative leadership and teacher support for immersion. In contrast, middle schools that had more negative values on the Implementation Index generally had negative values for nearly all of the immersion components. These findings suggest that the implementation indices are relatively effective in discriminating higher and lower implementing schools. Still, there are exceptions to the prevailing trends. Some schools, such as MS 3, had generally higher implementation values for most of the indicators except Parent/Community Support (-0.75). This suggests that gaining full parent support was a problem for that school in the third year. In other schools, such as MS 13, students reported higher levels of

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[4] Two schools did not submit spring 2007 student surveys, so those schools do not have scores for Student Access and Use or the Implementation Index.

technology access and use even though strong implementation supports were not in place, and their teachers' level of Classroom Immersion was low.

Campus-level results for the Implementation Index displayed in Figure 3.12 illustrate the variation in the levels of technology immersion for the 19 middle schools with scores for the third project year. Results for the Implementation Index combined with evidence from standards-based scores suggest that about a quarter of middle schools (5), with Implementation Index scores ranging from 0.72 to 1.89 standard deviations above the mean, have a stronger presence of the components of technology immersion compared to other schools, thus a higher level of implementation that more nearly approximates expected standards.

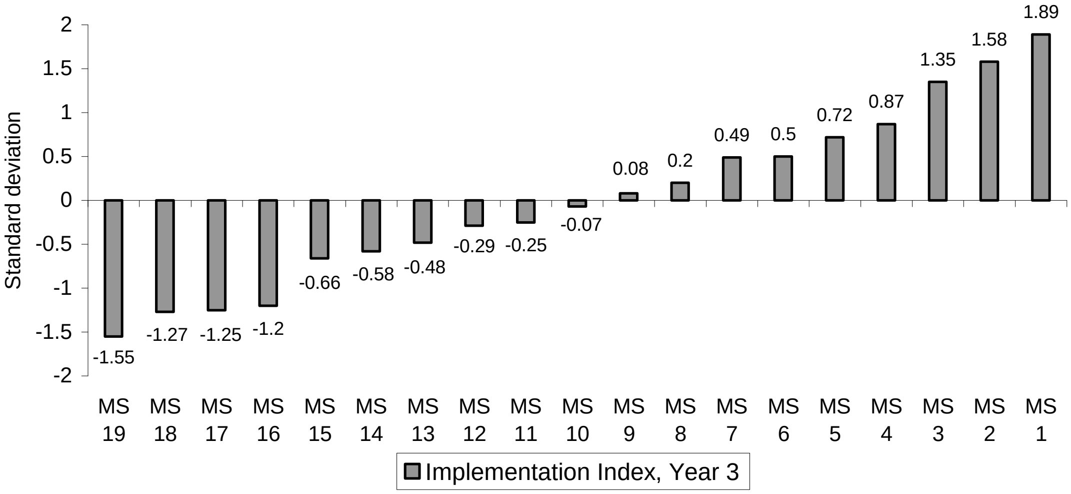

**Figure 3.12. Campus means for 19 immersion middle schools (MS) on the Technology Immersion Implementation Index (standardized scores [*z* scores] with a mean of 0 and a standard deviation of 1.0).**

## Conclusions

This chapter described the components of technology immersion, as defined by the TEA and operationalized through technology immersion packages. In the second and third project years, we measured implementation using a two-part approach: (a) designation of standards defining four levels of immersion (*minimal*, *partial*, *substantial*, and *full)*, and (b) calculation of standardized implementation indices (*z* scores). Both types of scores 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.

- Mean immersion standard scores revealed small increases between the second implementation year (2005-06) and the third year (2006-07) for each of the support components (Leadership, Teacher Support, Parent/Community Support, Technical Support, and Professional Development) as well as teachers' overall level of Classroom Immersion. In contrast, the level of Student Access and Use was stable across years.
- Despite improvements, mean third-year immersion standard scores (ranging from 2.51 to 3.14) showed that many schools needed stronger supports, especially in the areas of school leadership, parent and community support for technology use, technical supports that addressed obstacles to technology use, and professional development.

- Consistent with the second project year, core-subject teachers at the majority of schools reported only partial levels of Classroom Immersion in the third year. Teachers' mean scores at a few schools, however, revealed progress in creating technology-immersed classrooms. Accordingly, the standards-based implementation score for Classroom Immersion increased slightly across years (from 2.48 to 2.60).
- Immersion standard scores for each of five elements of Classroom Immersion showed slightly stronger implementation in the third year, with the largest increases for teachers' ideological affiliations with Technology Integration and Learner-Centered Instruction, and the smallest change for Student Activities with technology in the classroom. There were notable increases in teachers' use of technology as a communication tool and for the enhancement of their own professional productivity in the third year.
- Students' access to and use of laptops for learning within and outside of school generally fell short of expectations in the third year. Students at more than two-thirds of schools had partial levels of access and use (mean immersion standard scores of 2.38 and 2.35 across years), whereas students at about a third of schools had only minimal access and use (mean immersion scores of 1.60 and 1.74 across years).
- 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. Year-to-year comparisons indicated that the mean implementation level for Laptop Access Days declined between the second and third project years (from 2.69 to 2.50). Partial levels of implementation indicated that student access days generally varied at schools to a *large extent* (from 100 to 176 days per student). In contrast to laptop days, students reported small increases in the third year in their use of laptops for Core-Content Learning and Home Learning.
- Implementation indices (*z* scores) described each school's level of implementation for the components of technology immersion. Third-year evidence from immersion standard scores and the Implementation Index, a composite score measuring the overall presence of immersion components, indicated that about a quarter of middle schools (5) had a much stronger presence of the immersion components compared to other schools. Thus, these schools had a higher level of immersion that more nearly approximated expected implementation standards.

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

# 4. Effects of Technology Immersion on Teachers and Teaching

In the theoretical model, researchers hypothesize that quality implementation of technology immersion (i.e., supportive school leaders, teacher commitment to technology innovation, professional development supporting curricular integration, adequate technical and pedagogical support to maintain an immersed campus, and robust student technology access) should lead to teachers who have greater technology proficiency, use technology more for their own professional productivity, hold a more favorable pedagogical orientation toward technology, and collaborate more often with their peers to advance teaching and learning through technology. Moreover, teachers in schools that achieve higher levels of school and classroom immersion will use laptops as a tool to increase the intellectual challenge of lessons and will have students who use technology more often in their classrooms.

Contrary to expectations, results reported in Chapter 3 revealed that school-level supports for technology immersion generally did not meet full immersion standards, and accordingly, teachers at the majority of schools reported just partial levels of Classroom Immersion. Additionally, as noted in the methodology, control schools began to plan for technology immersion in the third year. Thus, most of the control teachers received new laptops and instructional resources along with increased opportunities for technology-related professional development. Recognizing that these factors may influence outcomes, we have investigated the effect of technology immersion on teachers, given that the level of implementation at treatment schools was generally low and control teachers began to benefit from elements of the treatment.

Findings on the effects of technology immersion on teacher-mediating variables come from online surveys of teachers completed in fall 2004 ($N$ = 1,271) and again in spring of 2005 ($N$ = 1,144), 2006 $N$ = 1,175), and 2007 ($N$ = 1,208). Teachers responded to items pertaining to their personal and classroom technology experiences. Response rates ranged from 87% to 98% across survey administrations, with only small differences between comparison groups. 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 Collaboration with peers on technology. Cronbach's alpha reliability coefficients for the teacher-level scale scores ranged from 0.66 to 0.98. (See Appendix C for technical details.)

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

## Teacher Mediating Variables—HLM Analysis

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 four occasions: fall 2004 (baseline), spring 2005 (after the first implementation year), spring 2006 (after the second year), and spring 2007 (after the third year). Our analytical sample included 1,684 teachers who taught at schools at some point during three implementation years, with 816 in 21 technology immersion schools and 868 in 21 control schools. Thus, we included teachers in the analyses even if they were not measured at all four time points. Because multilevel regression models do not assume equal numbers of observations (i.e., occasions of measurement), respondents with missing data can remain in the analysis (Hedeker, 2004; Hox, 2002). HLM, however, requires complete data at the teacher and school levels, so teachers were omitted if, for example, they were missing demographic information such as ethnicity. Our analytic approach mitigated problems associated with the substantial loss of teachers from analyses due to generally high teacher attrition rates each year of the study and varying teacher turnover rates across schools. For example, while the annual average teacher turnover rate was about 17%, school annual turnover rates varied from about 6% to about 42%.

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

### Level 1: Repeated-Measures Model

Level 1 is a repeated-measures model (i.e., survey time within teachers) that enables us to capture key features of growth (e.g., initial status, rate of change). In the model, $Y_{tij}$ is the survey scale score at year $t$ for teacher $i$ in school $j$. Survey Time is the point at which teachers completed the online surveys (0=fall 2004, 1=spring 2005, 2=spring 2006, 3=spring 2007). The key parameters in the model are $\pi_{0ij}$ and $\pi_{1ij}$. The coefficient $\pi_{0ij}$ represents the "initial status" (that is, the initial survey scale score) for teacher $i$ in school $j$ in fall 2004, and $\pi_{1ij}$ 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, $\pi_{0ij}$ is the teacher's initial survey scale score and $\pi_{1ij}$ is the teacher's rate of growth per school year. In the model, $\beta_{00j}$ represents the mean initial status within school $j$, and $\beta_{10j}$ 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 ($\mu_{00j}$ and $\mu_{10j}$) 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, $\beta_{00j}$ is the mean initial status for teachers in school $j$ and $\gamma_{000}$ is the overall mean initial status (grand mean); $\beta_{10j}$ is the mean teacher growth rate in school $j$ and $\gamma_{100}$ is the overall mean teacher growth rate. Immersion status is an indicator variable with a value of 0 for a control school and a value of 1 for an immersion school. School poverty is a continuous variable with percentages ranging from ranging from 31% to 100%, with a mean of 69.8%. The coefficients $\gamma_{001}$ and $\gamma_{101}$ represent the direction and strength of association of immersion status and school-level initial status.

## Effects of Immersion on Teachers

After adjusting for school poverty, technology immersion had a statistically significant effect on teachers' rates of growth for six technology-related variables (Table 4.1). 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), the frequency of Student Classroom Activities (with technology), and Collaborative interactions with colleagues on technology-related issues. In contrast, there was no significant effect of immersion on teachers' Resistance to Integration.

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

| | | Statistics for Teachers in Immersion Schools with Average School Poverty[c] | | | |
|---|---|---|---|---|---|
| | Immersion Effect Net of School Poverty | Average Estimated Initial Status Fall 2004 | Yearly Growth Rate | Average Estimated Score Spring 2007 | Yearly Growth Rate for Control Teachers |
| Technology Proficiency[a] | Yes | 4.49 | 0.31*** | 5.42 | 0.13*** |
| Professional Productivity[b] | Yes | 2.93 | 0.20*** | 3.53 | 0.08*** |
| Ideology | | | | | |
| Technology Integration[a] | Yes | 3.18 | 0.59*** | 4.95 | 0.24*** |
| Learner-Centered Instruction[a] | Yes | 3.64 | 0.38*** | 4.79 | 0.20*** |
| Resistance to Integration[a] | No | 2.15 | 0.02 | 2.20 | 0.03 |
| Student Classroom Activities[b] | Yes | 1.96 | 0.23*** | 2.66 | 0.03* |
| Collaboration[b] | Yes | 2.41 | 0.10** | 2.71 | 0.04 |

*Source:* Online teacher surveys conducted in fall 2004, spring 2005, spring 2006, and spring 2007.
**p* < .05. ***p* < .01. ****p* < .001.
[a] Items measured on a 7-point scale. [b] Items measured on a 5-point scale.

Unlike previous years, control teachers also had significantly positive growth trends for technology-related variables in the third year. Although control teachers' yearly growth rates were significantly less steep than rates for immersion teachers, the introduction of technology resources in control schools had a positive effect on teachers' technology proficiencies, ideology, and to a lesser extent, on their students' classroom activities and their collaboration with peers on technology-related issues.

Figure 4.1 illustrates the estimated growth trajectories for teachers in immersion schools with average levels of school poverty. Teachers have positive growth trajectories for all of the technology-related indicators, with the exception of Resistance to Integration, which remained stable across years.

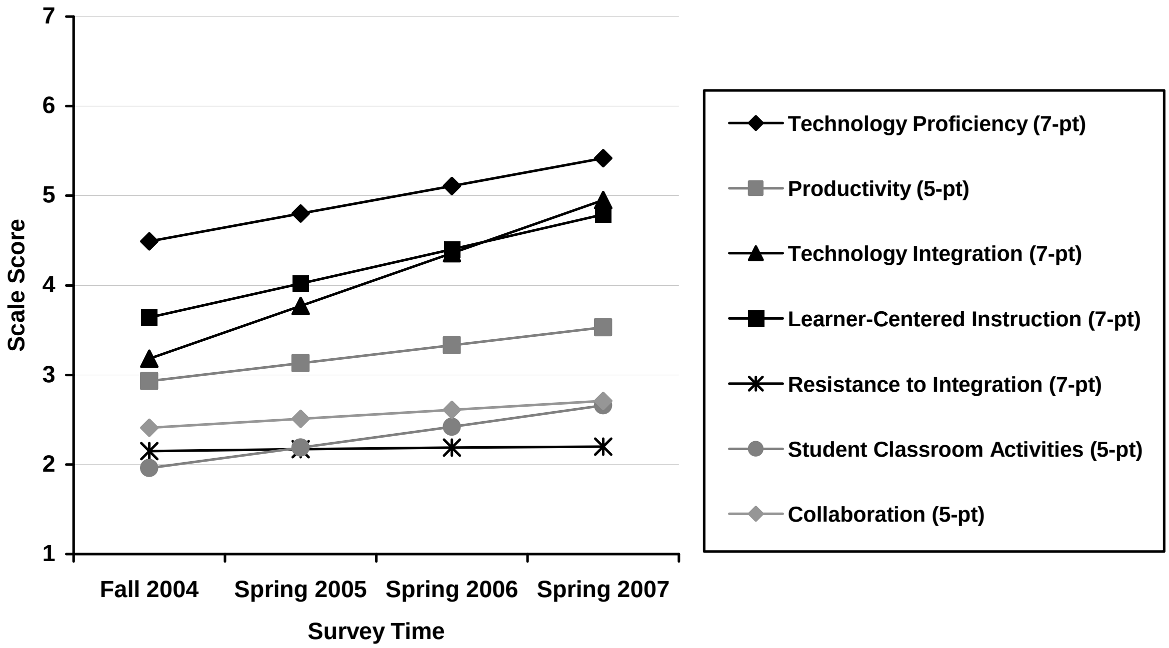

**Figure 4.1. Estimated mean growth trajectories for Technology Immersion teachers working in schools with average levels of school poverty on technology-related indicators (ratings on either 5-point or 7-point scales).**

Sections to follow explain changes in teachers' knowledge and skills, ideology, classroom practices, and peer collaboration. Tables 4.2, 4.3, and 4.4 provide school-level statistics for the HLM analyses of immersion effects on teacher mediating variables.

## Technology Knowledge and Skills

Texas Technology Applications Standards require *all* teachers to master and use technology-related terminology, concepts, and strategies, and to use tools to accomplish a range of tasks (e.g., communicate with diverse audiences and analyze electronic information). Given the importance of teachers' 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 ranging from 1 (*not true of me now*) to 7 (*very true of me now*). The proficiency scale included items measuring technology operations (e.g., send email to coworkers, parents, or peers; search for and find a Web site; find primary sources of information on the Internet) and items related to classroom instruction (e.g., using the computer for presentations or creating a lesson plan or unit incorporating technology).

HLM statistics in Table 4.2 show that immersion teachers grew in technology proficiency at a significantly faster rate (0.31 scale-score point per year) than control teachers (0.13 point per year) Immersion teachers began with slightly lower mean proficiency scores than control teachers in fall

2004, but they surpassed control teachers in spring 2005 and continued to widen the proficiency gap during the next two school years.

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

| Dependent variable and predictor | Technology Proficiency | | Professional Productivity | |
|---|---|---|---|---|
| | Gamma Coefficient | *t*-value | Gamma Coefficient | *t*-value |
| Initial status (fall 2004) | 4.673 | 54.61*** | 3.023 | 49.94*** |
| Immersion | -0.184 | -1.52 | -0.094 | -1.14 |
| School Poverty | -0.001 | -0.40 | 0.000 | 0.12 |
| Growth rate | 0.134 | 6.35*** | 0.084 | 8.16*** |
| Immersion | 0.176 | 5.72*** | 0.117 | 6.17*** |
| School Poverty | -0.002 | -2.44* | -0.001 | -0.88 |

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

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 0.002 scale-score decrease in proficiency. Thus, as Figure 4.2 illustrates, a 20% decrease in school poverty predicts a 0.04 point increase in teachers' yearly growth in proficiency (i.e., 20 *x* 0.002); a 20% increase in school poverty predicts a 0.04 point decrease in teachers' yearly growth. As the level of school poverty increases, the teacher proficiency gap widens.

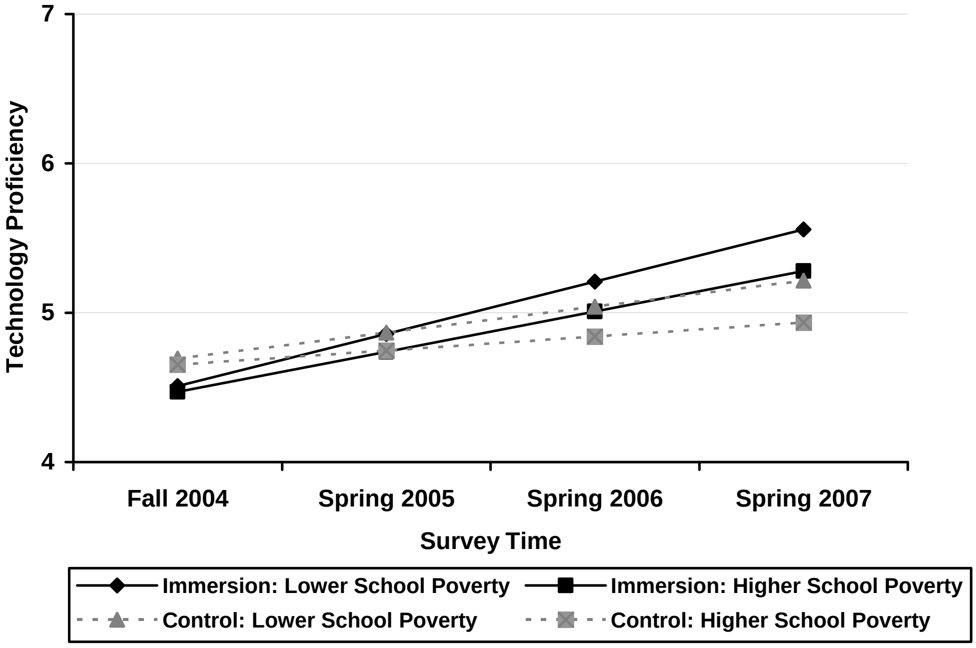

**Figure 4.2. Estimated mean growth trajectories for teachers at immersion and control schools for Technology Proficiency (ratings on a 7-point scale). Comparisons are for teachers working in schools with lower and higher concentrations of school poverty (20% above average and 20% below average).**

Teachers also rated the frequency with which they used technology for Professional Productivity on a 5-point scale ranging from 1 (*never*) to 5 (*almost daily*). Productivity items, for example, measured teachers’ use of technology for administrative, classroom management, communication, and instructional purposes. Similar to findings for Technology Proficiency, teachers at immersion schools had significantly steeper rates of growth than control teachers in the use of technology to improve their productivity. The estimated yearly mean growth trajectories for immersion and control teachers in schools with average poverty were 0.20 and 0.08 scale-score points per year, respectively. Teachers working in schools with higher percentages of disadvantaged students grew at slightly slower 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*). Items from the Levels of Technology Implementation (LoTi) Questionnaire (Moersch, 2001) measured three latent variables (Technology Integration, Learner-Centered Instruction, and Resistance to Integration). HLM results detailed in Table 4.3 show that teachers at immersion schools, on average, became more positive towards innovative technology practices across time.

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

| Dependent variable and predictor | Technology Integration[a] | | Learner-Centered Instruction | | Resistance to Integration[b] | |
|---|---|---|---|---|---|---|
| | Gamma Coefficient | *t*-value | Gamma Coefficient | *t*-value | Gamma Coefficient | *t*-value |
| Initial status (fall 2004) | 2.885 | 41.52*** | 3.670 | 60.79*** | 2.434 | 50.38*** |
| Immersion | 0.298 | 2.89** | -0.028 | -0.32 | -0.281 | -4.34*** |
| School Poverty | 0.008 | 2.72* | 0.006 | 2.55* | -0.272 | -1.72 |
| Growth rate | 0.237 | 7.14*** | 0.198 | 7.79*** | 0.032 | 1.85 |
| Immersion | 0.348 | 6.96*** | 0.186 | 4.54*** | -0.017 | -0.58 |
| School Poverty | -0.003 | -1.76 | -0.002 | -1.40 | 0.001 | 1.12 |

**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 = -0.46).

[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 schools had a significantly more positive rate of change for Technology Integration than control teachers. The mean estimated growth trajectory for immersion teachers who worked in schools having average levels of school poverty was 0.59 scale-score point per year compared to 0.24 for control teachers.

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 schools with average poverty was 0.38 and 0.20 scale-score points, respectively. Teachers in schools with higher concentrations of school poverty had somewhat slower rates of growth relative to both technology integration and learner-centered practices.

For the Resistance to Integration scale, teachers expressed their strength of association with items 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 constant across years.

### Student Classroom Activities and Teacher Collaboration

Table 4.4 provides HLM statistics for measures of teachers' classroom activities and collegial collaboration. The Student Classroom Activities scale provided an estimate of the frequency—on a 5-point scale ranging from 1 (*never*) to 5 (*almost daily*)—with which teachers had students in their typical class use technology in various ways. For example, teachers might have students use technology for writing, learning and practicing skills, communication, or Internet research. As expected, given the availability of laptops at immersion schools, teachers at treatment schools had a significantly faster growth rate for Student Classroom Activities (0.23 and 0.03 scale-score points per year, respectively, for immersion and control teachers in schools with average poverty). School poverty had no discernable effect on teachers' growth rate for the frequency of students' classroom activities involving technology. Even though immersion teachers had their students use technology in classrooms at an increasingly more frequent rate, estimated mean scores indicated that by spring 2007 teachers, on average, had students use various technology applications in their classes infrequently (about once or twice a month, *M* = 2.65).

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

| | Student Classroom Activities | | Teacher Collaboration | |
|---|---|---|---|---|
| Dependent variable and predictor | Gamma Coefficient | *t*-value | Gamma Coefficient | *t*-value |
| Initial status (fall 2004) | 1.888 | 40.47*** | 2.300 | 44.77*** |
| Immersion | 0.075 | 1.17 | 0.107 | 1.49 |
| School Poverty | 0.004 | 2.23* | 0.003 | 1.74 |
| Growth rate | 0.034 | 2.36* | 0.035 | 1.92 |
| Immersion | 0.199 | 7.43*** | 0.065 | 2.20* |
| School Poverty | -0.001 | -0.91 | 0.000 | 0.06 |

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

We also reasoned that a greater abundance of technology resources and opportunities for shared professional development would lead to stronger teacher connections. Accordingly, the Collaboration scale measured teacher interactions with colleagues that supported improvements in instructional practices, such as coaching and mentoring, collectively developing technology lessons, and exchanging information about their students. As expected, immersion teachers had a steeper mean yearly growth trend for Collaboration (0.10 scale-score point) than control teachers (0.04 point). Campus poverty had a negligible effect on teacher collaboration.

## Effects of Immersion on Classroom Practice

To further understand teachers' instructional practices, researchers conducted classroom observations in samples of core-subject classrooms (reading/English language arts, mathematics, science, and social studies) each year. In fall 2004 and spring 2005, we observed sixth-grade teachers of Cohort 1 students. In spring 2006, the classroom sample included observations of seventh-grade teachers of

Cohort 1 students and sixth-grade teachers of Cohort 2 students. In spring 2007, the sample included eighth-grade teachers of Cohort 1 students, seventh-grade teachers of Cohort 2 students, and sixth-grade teachers of Cohort 3 students. To the extent possible, we conducted follow-up observations for teachers who remained at the schools across years.

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

Across data-collection periods, observations at treatment and control schools included nearly equal proportions of teachers by subject-area taught, gender, highest degree earned, and years teaching experience. Observations included somewhat more English language arts and reading teachers (27% to 30% of observed teachers), and somewhat less mathematics teachers (19% to 28%), social studies teachers (17% to 28%), and science teachers (13% to 23%). Variations reflected our interest in documenting the instructional practices of teachers whose students were included in cohorts being tracked across years and their TAKS-tested subject areas.

During observations, data collectors used the Observation of Teaching and Learning (OTL) instrument to record descriptive information about the classroom environment, and to make time-interval ratings for classroom organization, teacher activities and technology use, student activities and technology use, student engagement, and student collaboration. Observers also recorded notes during the observations to capture the lesson's content focus and objectives, teachers' questioning strategies (lower and higher order), and students' learning experiences. Following classroom observations, observers used time-interval ratings and descriptive notes to rate the *Intellectual Challenge* of classroom work (rating scales developed by Newmann, Secada, & Wehlage, 1995). One section of the OTL included 5-point rating scales for four standards of the intellectual quality of instruction:

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

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

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

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

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

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

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

Table 4.6 summarizes findings across the data collection periods for each of the Intellectual Challenge domains. Effect sizes show that control teachers' instruction in fall 2004, compared to immersion teachers, had a higher mean level of intellectual challenge for each of the four standards.  However, in spring 2005, immersion teachers' lessons received higher ratings for Higher Order Thinking (ES = 0.18) and Depth of Knowledge (ES = 0.09). In spring 2006 and 2007, immersion teachers' lessons, compared to control teachers, received higher Intellectual Challenge scores for each of the four standards. Effect sizes indicated that immersion teachers had a greater instructional emphasis on Higher Order Thinking (0.22 in 2006, 0.28 in 2007) and Connections beyond the Classroom (0.06 in 2006, and 0.18 in 2007).

In general, evidence accumulating over time suggests that the availability of laptop computers and digital resources has allowed students in technology immersion schools to experience more intellectually demanding work. Even so, the results across all observed classrooms indicate that lessons in middle-school core classes generally fail to intellectually challenge students, with average ratings mostly below 2 on the 5-point intellectual challenge of instruction scales.

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

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

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

## Conclusions

Although the level of implementation was generally low at many technology immersion schools in the third year, and control teachers benefited from initial steps toward the implementation of the technology immersion model (teacher laptops, digital resources, and targeted professional development), we found that being in a technology immersion school 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 teachers' 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.

- Accumulating evidence suggests that the availability of laptop computers and digital resources has allowed students in technology immersion schools to experience more intellectually demanding work. However, ratings of the Intellectual Challenge of classroom instruction indicate that the intellectual demand of core-subject lessons was typically low across all middle-school classrooms.

# 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. 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 and express a stronger ideological affiliation with immersion practices, and both teachers and their students use technology more often. Considering school and classroom conditions, 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 three cohorts of students as baseline measures in fall and again as post-measures in spring of each project year. 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 71% to 89% across administrations. With the exception of spring 2005, there were only slight differences in *SLI* response rates between cohorts and comparison groups. (See additional detail in the methodology chapter.)

Sections to follow present findings for the three student cohorts. Since Cohorts 1 and 2 students completed surveys at three or more time points, we used hierarchical linear modeling (HLM) growth models to examine the effects of technology immersion on students' individual growth rates for various measures. Cohort 3 students completed surveys at two time points, so we use HLM to estimate the effects of technology immersion on students' spring scale scores. For all student groups, immersion effects are estimated for the following scales: Classroom Activities, Small-Group Work, Technical Problems, Technology Proficiency, Self-Directed Learning, and School Satisfaction. Cronbach's alpha coefficients (measures of internal consistency reliability) for student-level scales ranged from 0.77 to 0.94 (see Appendix C for details).

## HLM Analyses

### HLM Growth Analysis for Cohorts 1 and 2 Students

Longitudinal data allowed researchers to examine the nature of student change over time. For Cohort 1, we collected data at four time points: fall 2004 (baseline) and spring 2005, 2006, and 2007 (after the first, second, and third implementation years, respectively). For Cohort 2, we collected data at three time points: fall 2005 (baseline) and spring 2006 and 2007 (after the first and second implementation years). Analyses contrast the growth trajectories for 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 (Cohort 1, 0 = fall 2004, 1 = spring 2005, 2 = spring 2006, and 3 = spring 2007; Cohort 2, 0 = fall 2005, 1 = spring 2006, and 2 = spring 2007). The key parameters in the model are $\pi_{0ij}$ and $\pi_{1ij}$. The coefficient $\pi_{0ij}$ represents the "initial status" (that is, the estimated initial scale score), for student *i* in school *j* in fall, and $\pi_{1ij}$ is the annual growth rate (rate of change) for student *i* in school *j*. The $e_{tij}$ is the error term (within-student measurement error) assumed to be normally distributed with a mean of 0 and a constant variance. Thus, at level 1, the model is

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

**Level 2: Student-level model.** The Level 2 model (between-students model) allows us to determine differences between students in features of growth (e.g., initial status [$\pi_{0ij}$], rate of change [$\pi_{1ij}$]). In the student-level model, $\beta_{00j}$ represents the mean initial status of a more advantaged student (advantaged = 0, disadvantaged = 1) within school *j*, and $\beta_{10j}$ represents the mean rate of change for an advantaged student within school *j*. The coefficients $\beta_{01j}$ and $\beta_{11j}$ 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 ($\beta_{00j}$) and growth ($\beta_{10j}$) vary across schools as a function of school-level random effects ($\mu_{00j}$ and $\mu_{10j}$), as well as school conditions, including immersion status (an indicator variable with a value of 0 for a control school and a value of 1 for an immersion school) and school poverty (a continuous variable with percentages ranging from 31% to 100%, and with a grand mean of 69.8%). 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, $\gamma_{000}$ is the overall mean initial status of an advantaged student at a control campus with an average level of school poverty, and $\gamma_{100}$ is the overall mean student growth rate (of an advantaged student at a control campus with an average level of school poverty). The coefficients $\gamma_{001}$ and $\gamma_{101}$ represent the direction and strength of association of immersion status on school-level initial status and growth rate, respectively. In addition, $\gamma_{002}$ and $\gamma_{102}$ represent the effect of school poverty on school-level initial status and growth rate, respectively. Analyses for Cohort 1 involved a total of 2,804 students who were continuously enrolled in schools since October 2004, with 1,337 at immersion schools and 1,467 at control schools. Analyses for Cohort 2 involved 3,266 students continuously enrolled since October 2005, with 1,595 at immersion schools and 1,671 at control schools.

### *HLM Analysis for Cohort 3 Students*

We analyzed the effects of immersion on Cohort 3 students' scale scores for mediating variables using two-level hierarchical linear models.

**Level 1: Student-level model.** In the student-level model, spring 2007 scale scores from surveys were regressed on fall 2006 scale scores, economic status (0 if not disadvantaged, 1 if disadvantaged), African American status (0 if not African American, 1 if African American), Hispanic status (0 if not Hispanic, 1 if Hispanic) and gender (0 if male, 1 if female). That is,

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

**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,

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

Immersion was an indicator variable with a value of 0 for a control school and 1 for an immersion school. School poverty was a continuous variable with percentages ranging from 31% to 100%, and a grand mean of 69.8%. For two-level HLM models, we calculated effect sizes (ES) in standard deviation units (Cohen's *d)*. Effect sizes greater than 0.5 are typically interpreted as large, 0.5 to 0.3 as moderate, 0.3 to 0.1 as small, and less than 0.1 as trivial. Analyses for Cohort 3 involved a total of 3,993 students who were continuously enrolled in schools since October 2006, with 1,829 at immersion schools and 2,164 at control schools.

## Immersion Effects on Technology Experiences and Self-Perceptions

### *Cohorts 1 and 2*

Analyses for Cohorts 1 and 2 involved the estimation of six, three-level HLM growth models. As Table 5.1 shows, we used separate models to estimate the effects of technology immersion on growth rates for measures of students' school technology experiences, including Classroom Activities, Small-Group Work, and Technical Problems, as well as students' self-perceptions of their Technology Proficiency, Self-Directed Learning, and School Satisfaction. Summary results show that technology immersion had positive effects on students in a number of areas. After controls for school poverty (percentage of economically disadvantaged students) and student economic disadvantage (qualification for free- or reduced-price lunch), estimated mean yearly rates of change for advantaged and disadvantaged immersion students revealed positive growth trends favoring immersion students for Classroom Activities, Small-Group Work, and Technology Proficiency. Growth rates also showed that immersion students, compared to control, reported mounting Technical Problems using computers over time, with the growth-rate difference between groups statistically significant for Cohort 1 eighth graders.

The technology immersion model also assumes that having daily access to and personal responsibility for laptop computers will allow immersion students to become more Self-Directed Learners and will increase their School Satisfaction. Contrary to expectations, we found that as students in both the treatment and control groups advanced from sixth to eighth grade, they reported being less self-directed learners and expressed less satisfaction with school. There were no statistically significant differences between the views of immersion and control-group students.

**Table 5.1. Cohorts 1 and 2: 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 |
| **Cohort 1 (8th Graders)** | | | | | |
| **School Technology** | | | | | |
| Classroom Activities (5-pt) | Yes*** | 0.25 | 0.30 | 0.04 | 0.08 |
| Small-Group Work (5-pt) | Yes** | 0.02 | 0.07 | -0.06 | 0.00 |
| Technical Problems (5-pt) | Yes* | 0.15 | 0.17 | 0.10 | 0.13 |
| **Student Self-Perceptions** | | | | | |
| Technology Proficiency (5-pt) | Yes | 0.31 | 0.38*** | 0.27 | 0.28 |
| Self-Directed Learning (7-pt) | No | -0.07 | -0.09 | -0.05 | -0.07 |
| School Satisfaction (5-pt) | No | -0.06 | -0.03 | -0.06 | -0.02 |
| **Cohort 2 (7th Graders)** | | | | | |
| **School Technology** | | | | | |
| Classroom Activities (5-pt) | Yes*** | 0.30 | 0.34 | 0.06 | 0.10 |
| Small-Group Work (5-pt) | Yes** | 0.14 | 0.13 | -0.01 | -0.02 |
| Technical Problems (5-pt) | No | 0.24 | 0.24 | 0.17 | 0.17 |
| **Student Self-Perceptions** | | | | | |
| Technology Proficiency (5-pt) | Yes*** | 0.43 | 0.43 | 0.27 | 0.27 |
| Self-Directed Learning (7-pt) | No | -0.11 | -0.11 | -0.14 | -0.13 |
| School Satisfaction (5-pt) | No | -0.10 | -0.07 | -0.08 | -0.05 |

*Source:* Student surveys completed during the 2004-05, 2005-06, and 2006-07 school years.
*Note.* *$p < .05$. **$p < .01$. ***$p < .001$. Items measured on either a 5-point or 7-point scale.

### *Cohort 3*

Analyses for Cohort 3 involved the estimation of six, two-level HLM models. We used separate models to assess the effects of technology immersion on students' spring 2007 scores for the measures of school technology and student self-perceptions. Summary results presented in Table 5.2, similar to findings for Cohorts 1 and 2, show that technology immersion had a statistically significantly effect on four of the six mediating variables. After adjusting for fall 2006 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 sixth graders' spring scale scores for Classroom Activities (ES = 0.79), Small-Group Work (ES = 0.29), and Technology Proficiency (ES = 0.30). And, consistent with Cohort 1, Cohort 3 immersion students reported having technical problems with computers significantly more often than their control-group counterparts (ES = 0.22). Also like Cohorts 1 and 2, there were no statistically significant effects of immersion on students' Self-Directed Learning or School Satisfaction.

**Table 5.2. Cohort 3 (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 |
|---|---|---|
| **School Technology** | | |
| Classroom Activities | Yes*** | 0.79 (large) |
| Small-Group Work | Yes*** | 0.29 (small) |
| Technical Problems | Yes* | 0.22 (small) |
| **Student Self-Perceptions** | | |
| Technology Proficiency | Yes*** | 0.30 (small) |
| Self-Directed Learning | No | 0.11 (small) |
| School Satisfaction | No | 0.08 (trivial) |

*Source:* Student surveys completed in fall 2006 and spring 2007.

*Note*. *$p < .05$. **$p < .01$. ***$p < .001$. 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 less than 0.1 is trivial.

Sections to follow provide additional details for the HLM analyses. Student responses to specific scales help to explain outcomes for economically advantaged and disadvantaged students in technology immersion and control schools.

### *School Technology*

Table 5.3 provides statistics for the HLM growth models estimating the immersion effects on Cohorts 1 and 2 students' technology experiences. Specific scales are discussed below.

**Classroom Activities.** Students reported the frequency with which their teachers had them use specific technology applications (e.g., use a word processor for writing, use a spreadsheet to calculate or graph, create a presentation) in their English language arts, mathematics, social studies, and science classes combined. Students reported their technology use on a 5-point scale ranging from 1 (*never*) to 5 (*almost daily*). As anticipated given the 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. For Cohort 1 students, the yearly rates of change in Classroom Activities involving technology for economically advantaged and disadvantaged immersion students were 0.25 and 0.30 scale-score points, respectively. In contrast, advantaged and disadvantaged control students had relatively flat rates of change for classroom technology use (0.04 and 0.08 scale-score points, respectively). Similarly, the yearly rates of change in Classroom Activities for economically advantaged and disadvantaged Cohort 2 immersion students were 0.30 and 0.34 scale-score points, respectively, whereas advantaged and disadvantaged control students had relatively flat rates of change (0.06 and 0.10 scale-score points, respectively).

Figure 5.1 shows the estimated mean growth trajectories for the frequency of Classroom Activities for Cohort 1 students. Estimated mean scores for spring 2007 show that economically advantaged and disadvantaged students in immersion schools had Classroom Activities scores of 3.0 and 3.2, respectively, on the 5-point frequency scale, whereas mean scores for their control-group counterparts were 2.2 and 2.3, respectively. Despite significant increases in technology use by immersion students, mean use statistics indicated that students used various technology applications infrequently in classrooms (about once or twice a month).

**Table 5.3. Cohorts 1 and 2: Immersion (Fixed) Effect Analyses of School Technology Variables**

| Dependent variable and predictor | Classroom Activities (with technology) | | Small-Group Work | | Technical Problems | |
|---|---|---|---|---|---|---|
| | Gamma Coefficient | *t*-value | Gamma Coefficient | *t*-value | Gamma Coefficient | *t*-value |
| **Cohort 1 (8th Graders)** | | | | | | |
| Initial status (fall 2004) | 2.020 | 29.37*** | 2.802 | 48.73*** | 2.366 | 37.39*** |
| Immersion[a] | 0.257 | 3.26** | 0.058 | 0.99 | -0.138 | -1.95 |
| School Poverty | -0.298 | -1.34 | -0.154 | -0.80 | -0.324 | -1.30 |
| Economic Disadvantage | 0.013 | 0.43 | -0.051 | -0.96 | -0.071 | -1.04 |
| Growth rate | 0.040 | 1.63 | -0.055 | -2.56* | 0.101 | 3.27** |
| Immersion | 0.212 | 6.34*** | 0.072 | 2.79** | 0.095 | 2.43* |
| School Poverty | 0.082 | 0.86 | -0.052 | -0.59 | 0.073 | 0.53 |
| Economic Disadvantage | 0.044 | 3.08** | 0.056 | 2.79** | 0.024 | 0.93 |
| **Cohort 2 (7th Graders)** | | | | | | |
| Initial status (fall 2005) | 2.083 | 32.57*** | 2.786 | 45.50*** | 2.176 | 39.28*** |
| Immersion[b] | 0.145 | 1.57 | -0.062 | -0.76 | -0.295 | -3.94*** |
| School Poverty | 0.454 | 1.65 | 0.144 | 0.81 | 0.264 | 1.19 |
| Economic Disadvantage | -0.013 | -0.34 | -0.010 | -0.25 | -0.044 | -1.56 |
| Growth rate | 0.059 | 1.40 | -0.011 | -0.35 | 0.168 | 3.99** |
| Immersion | 0.244 | 4.16*** | 0.150 | 3.62** | 0.072 | 1.50 |
| School Poverty | -0.174 | -1.05 | -0.023 | -0.20 | -0.073 | -0.42 |
| Economic Disadvantage | 0.039 | 1.62 | -0.013 | -0.61 | 0.004 | 0.17 |

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

[a] Immersion students had significantly higher initial classroom activities scores. A latent variable regression, controlling for the effect of this initial difference on the growth rate, indicated that the difference between the original (0.138) and adjusted (0.212) immersion coefficients was significant (the difference divided by the standard error of the difference equals -2.63). The growth rate coefficient adjusted for this difference is reported in the table.

[b] Immersion students had 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 (0.254) and adjusted (0.072) immersion coefficients was significant (the difference divided by the standard error of the difference equals 3.32). The growth rate coefficient adjusted for this difference is reported in the table.

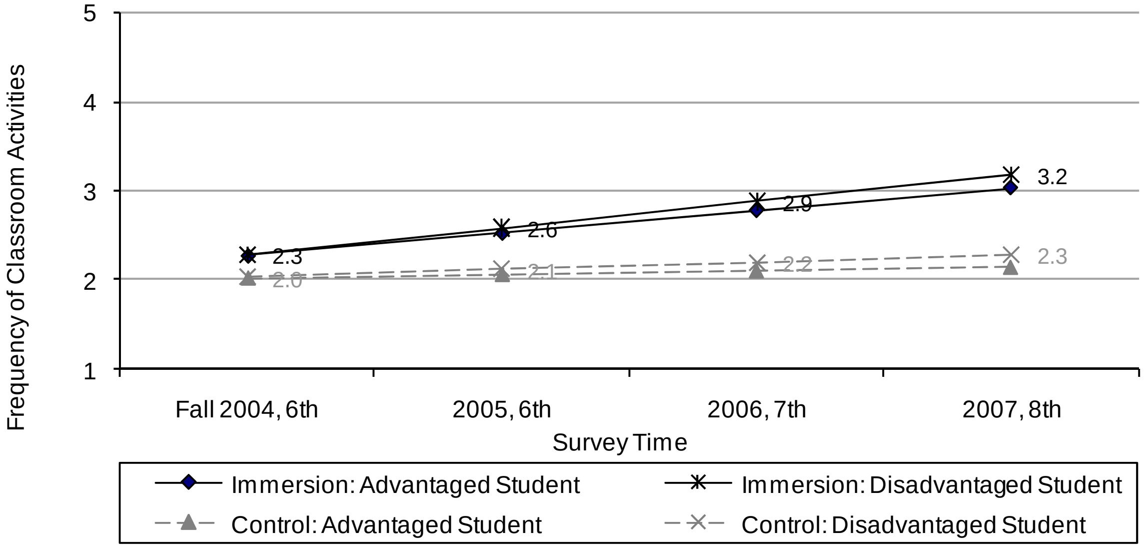

**Figure 5.1. Estimated mean growth trajectories for the frequency of Classroom Activities for Cohort 1 students, by economically advantaged and disadvantaged student groups in immersion and control schools. Statistics are displayed for disadvantaged students.**

**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 their peers. Across cohorts, economically advantaged and disadvantaged immersion students had significantly positive yearly growth rates (0.02 and 0.07 scale-score points, respectively, for Cohort 1; 0.14 and 0.13 scale-score points, respectively, for Cohort 2). Quite the opposite, students at control campuses reported less frequent small-group activities across survey times (yearly growth rates for advantaged and disadvantaged students ranged from 0 to -0.06 scale-score points).

**Technical Problems.** Given the increased availability of technology in immersion schools and classrooms, we reasoned that students might encounter more technical problems. Thus, we asked students to indicate on a 5-point scale about how often various Technical Problems happened when they tried to use a computer at school. Across Cohorts 1 and 2, growth rates showed that immersion students increasingly reported technical problems using computers compared to control students, and for Cohort 1 students, the growth-rate difference was statistically significant. Figure 5.2 shows that Cohort 1 immersion students initially reported fewer technical problems than control students, but by the end of eighth grade, both economically advantaged and disadvantaged immersion students reported more technical troubles. Still, mean scores in spring 2007 indicated that eighth graders, on average, rarely (a few times a year) or sometimes (once or twice a month) had problems using computers at school.

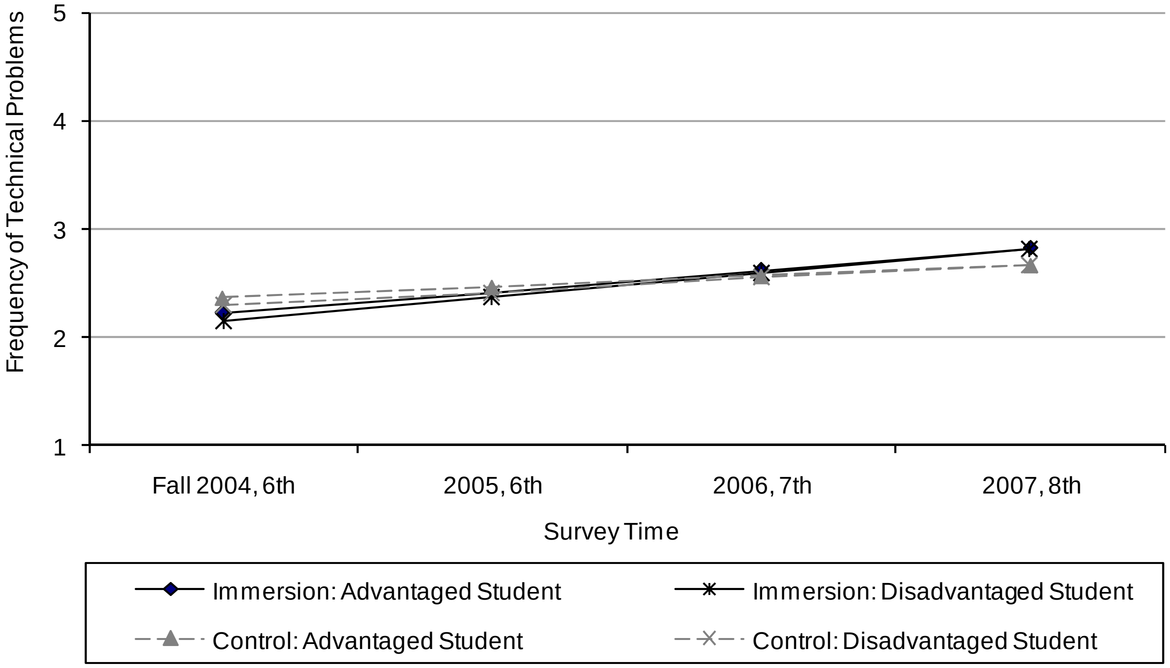

**Figure 5.2. Estimated mean growth trajectories for the frequency of Technical Problems for Cohort 1 students, by economically advantaged and disadvantaged student groups in immersion and control schools.**

Findings in Table 5.4 for Cohort 3 students generally mirror results for Cohorts 1 and 2. After adjusting for fall 2006 scale scores, student demographic characteristics (gender, ethnicity, economic disadvantage), and school poverty (percentage of economically disadvantaged students), technology immersion had a statistically significant effect on students' Classroom Activities (0.61 scale-score point) and Small-Group Work (0.31 scale-score point). Cohort 3 sixth graders at immersion schools also reported significantly more frequent Technical Problems than control-group students (0.21 scale-score point), but problems using computers occurred rarely (a few times a year).

**Table 5.4. Cohort 3 (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 | 1.998 | 35.66*** | 2.542 | 46.54*** | 2.243 | 31.22*** |
| Immersion | 0.610 | 8.51*** | 0.305 | 4.19*** | 0.209 | 2.65* |
| School poverty | -0.174 | -0.76 | 0.060 | 0.28 | 0.058 | 0.23 |
| Female | 0.004 | 0.18 | 0.076 | 3.50** | 0.034 | 1.17 |
| Hispanic | 0.046 | 1.57 | 0.044 | 1.30 | 0.008 | 0.15 |
| African American | 0.138 | 2.38* | 0.207 | 4.88*** | 0.007 | 0.11 |
| Disadvantaged | 0.112 | 3.66** | 0.059 | 1.44 | -0.010 | -0.29 |
| Fall 2006 score | 0.257 | 10.28*** | 0.254 | 15.65*** | 0.224 | 8.48*** |

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

### *Student Self-Perceptions*

Table 5.5 provides statistical details for the HLM growth models related to Cohorts 1 and 2 students' self-perceptions of their Technology Proficiency, Self-Directed Learning, and School Satisfaction. Individual scales are discussed below.

**Table 5.5. Cohorts 1 and 2: 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 |
| **Cohort 1 (8th Graders)** | | | | | | |
| Initial status (fall 2004) | 2.978 | 49.45*** | 4.552 | 89.97*** | 3.740 | 94.85*** |
| Immersion[a] | 0.043 | 0.56 | 0.106 | 2.12* | 0.064 | 1.66 |
| School Poverty | -0.126 | -0.54 | 0.339 | 2.22* | -0.131 | -0.20 |
| Economic Disadvantage | -0.341 | -8.75*** | -0.051 | -1.11 | -0.092 | -2.85** |
| Growth rate | 0.267 | 18.19*** | -0.049 | -3.60** | -0.055 | -5.41*** |
| Immersion | 0.043 | 1.53 | -0.017 | -1.01 | -0.008 | -1.80 |
| School Poverty | 0.005 | 0.06 | -0.023 | -0.55 | 0.163 | 3.23** |
| Economic Disadvantage | 0.008 | 0.64 | -0.023 | -1.68 | 0.034 | 1.29 |
| Economic x Immersion | 0.058 | 4.22*** | -- | -- | -- | -- |
| **Cohort 2 (7th Graders)** | | | | | | |
| Initial status (fall 2005) | 2.993 | 49.17*** | 4.787 | 90.41*** | 3.865 | 111.65*** |
| Immersion | 0.009 | 0.11 | -0.070 | -1.10 | 0.034 | 0.79 |
| School Poverty | 0.215 | 0.93 | 0.303 | 1.62 | -0.063 | -0.65 |
| Economic Disadvantage | -0.290 | -6.75*** | -0.129 | -3.57** | -0.138 | -5.90*** |
| Growth rate | 0.268 | 8.23*** | -0.137 | -7.11*** | -0.075 | -3.66** |
| Immersion | 0.160 | 4.25*** | 0.024 | 0.87 | -0.021 | -0.78 |
| School Poverty | -0.149 | -1.20 | -0.026 | -0.32 | 0.077 | 1.34 |
| Economic Disadvantage | 0.006 | 0.20 | 0.004 | 0.22 | 0.026 | 1.55 |

*$p$ < .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 = 0.88).

**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. Over the first two project years, Cohort 1 immersion students rated their Technology Proficiency as significantly more advanced than control-group students. By the end of eighth grade, however, a different trend emerged. A significant interaction was detected between technology immersion and students' economic status. While there was no main immersion effect on Cohort 1 students' growth in Technology Proficiency, economically disadvantaged students in immersion schools grew in proficiency at a significantly faster rate (0.38 scale-score point per year) compared to their more affluent immersion peers (0.31 scale-score point). Thus, as Figure 5.3 illustrates, by spring 2007, economically disadvantaged immersion students ($M$ = 3.8) narrowed the proficiency gap with advantaged immersion students ($M$ = 4.0), closed the proficiency gap with advantaged control students ($M$ = 3.8), and exceeded economically disadvantaged control students in proficiency ($M$ = 3.5). Thus, technology immersion had a positive and enduring effect on the technology proficiencies of economically disadvantaged students.

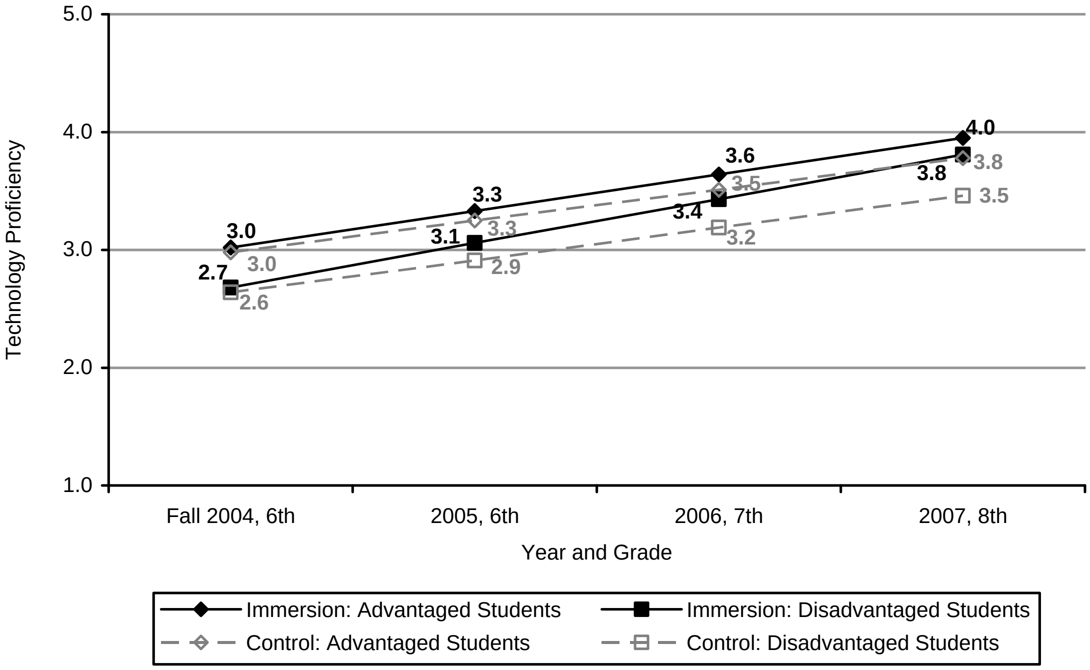

**Figure 5.3. Significant cross-level interaction between immersion and economically disadvantaged status for Cohort 1 Students' Technology Proficiency scores (in schools with average poverty).**

Results for Cohort 2 replicated results from previous project years. Both economically advantaged and disadvantaged immersion students grew in Technology Proficiency at a significantly faster rate than their counterparts in control schools. The yearly rates of change in proficiency for economically advantaged and disadvantaged students, respectively, in immersion schools were 0.43 and 0.43 scale-score points compared with 0.27 and 0.27 scale-score points for advantaged and disadvantaged control students. Thus, economically disadvantaged students in immersion schools surpassed advantaged control students in proficiency by the end of seventh grade (estimated mean scores of 3.6 and 3.5, respectively).

**Self-Directed Learning.** Self-direction, as measured by the *SLI* for this study, includes statements relative to students' *forethought* (e.g., goal setting, strategic planning, self-efficacy beliefs, intrinsic effort), *performance/volition control* (e.g., attention focusing, self-monitoring, and help seeking), and *self-reflection* (e.g., self-evaluation, adaptivity). Although prior research 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 effects on either Cohorts 1 or 2 students' growth in self-direction. As both immersion and control students progressed through seventh and eighth grade, their responses to statements revealed significantly negative growth trends. For Cohort 1, the estimated yearly rates of change in self-direction for advantaged and disadvantaged students in immersion schools were -0.07 and -0.09 scale-score points, respectively, compared to -0.05 and -0.07 scale-score points, respectively, for their control-group counterparts. Correspondingly, for Cohort 2, the estimated yearly rates of change in self-direction for advantaged and disadvantaged students were similarly negative for immersion students (-0.11 and -0.11, respectively) and control students (-0.14 and -0.13). Overall findings indicated that neither seventh nor eighth graders considered themselves to be strongly self-directed learners.

**School Satisfaction.** Students also rated their level of School Satisfaction by indicating the extent of their agreement with statements on a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). For example, students responded to items measuring their satisfaction with class work, the meaningfulness of class work, and the extent to which they perceived their class work to be useful to them in the future. As sixth graders, both immersion and control students generally *agreed* with statements measuring their school satisfaction. However, both treatment- and control-group students reported lower levels of school satisfaction across time. The estimated yearly rates of change in satisfaction for Cohorts 1 and 2 immersion students ranged from -0.03 to -0.10 scale-score points. Similarly, control students expressed declining levels of satisfaction (-0.02 to -0.08 scale-score points per year).

Findings for Cohort 3 students are consistent with results for Cohorts 1 and 2. After adjusting for fall 2006 scale scores, student demographic characteristics, and school, technology immersion had a significantly positive effect on students' 2006 scale scores for Technology Proficiency. On the other hand, there were no significant effects of immersion on sixth graders' Self-Directed Learning or School Satisfaction. Similar to previous years, females rated their technology proficiency as higher than males, they perceived themselves to be more self-directed learners, and they expressed greater satisfaction with the kind of academic work they do in middle schools.

**Table 5.6. Cohort 3 (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 | 3.144 | 62.11*** | 4.468 | 99.06*** | 3.625 | 77.67*** |
| Immersion | 0.330 | 6.56*** | 0.056 | 1.32 | 0.068 | 1.75 |
| School poverty | -0.345 | -2.48* | 0.067 | 0.51 | 0.075 | 0.48 |
| Female | 0.085 | 3.09** | 0.073 | 3.22** | 0.120 | 5.27*** |
| Hispanic | -0.012 | -0.37 | 0.017 | 0.38 | 0.026 | 0.57 |
| African American | -0.024 | -0.60 | 0.094 | 2.16* | -0.017 | -0.29 |
| Disadvantaged | -0.073 | -1.66 | -0.036 | -1.90 | -0.038 | -1.09 |
| Fall 2006 score | 0.526 | 23.36*** | 0.571 | 25.39*** | 0.396 | 12.49*** |

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

## Immersion Effects on Student Engagement

We also theorized that greater technology access and use would lead to improvements in student conduct, and consequently, fewer discipline problems as well as increased school attendance. Findings on student engagement presented below show that immersion had positive effects on student discipline and behavior, but negative effects on school attendance.

### *Student Discipline and Behavior*

As one measure of engagement, we collected student-level data from schools on disciplinary actions occurring during the 2006-07 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. Therefore, we compared the frequency of the disciplinary occurrences at treatment and control schools for Cohorts 1, 2, and 3 students. Preliminary statistical tests showed generally non-normal and negatively skewed distributions of disciplinary actions for each cohort (see Kolmogorov-Smirnov tests for normality in Table 5.7). However, because *t*-tests of differences between mean scores are robust to violations of the normality assumption (Rasch & Guiard, 2004), we used this parametric procedure to test for differences between groups. Results for independent *t*-tests show statistically significant differences between the frequency of disciplinary actions at immersion and control schools, favoring immersion across three cohorts (Table 5.7). Figure 5.4 compares the number of students and average number of disciplinary actions for immersion and control schools for each of the student cohorts.

**Table 5.7. Statistics for Comparisons of Disciplinary Actions at Immersion and Control Schools**

| Cohort | Kolmogorov-Smirnov *z* Test for Normality | Mann-Whitney Rank-Sum *U* Test z statistic | Independent Samples *t*-test | Effect Size |
|---|---|---|---|---|
| **Cohort 1** (8th Graders) | 1.27 | 3.18** | 4.09*** | -0.11 |
| **Cohort 2** (7th Graders) | 1.91** | 4.88*** | 5.83*** | -0.16 |
| **Cohort 3** (6th Graders) | 1.43* | 3.80*** | 4.93*** | -0.13 |

*Note*. **p* < .05. ***p* < .01. ****p* < .001. Two outliers were removed from the analyses: a Cohort 1 control student with 112 disciplinary actions and a Cohort 3 immersion student with 111 disciplinary actions. Removing the outliers did not affect the conclusions.

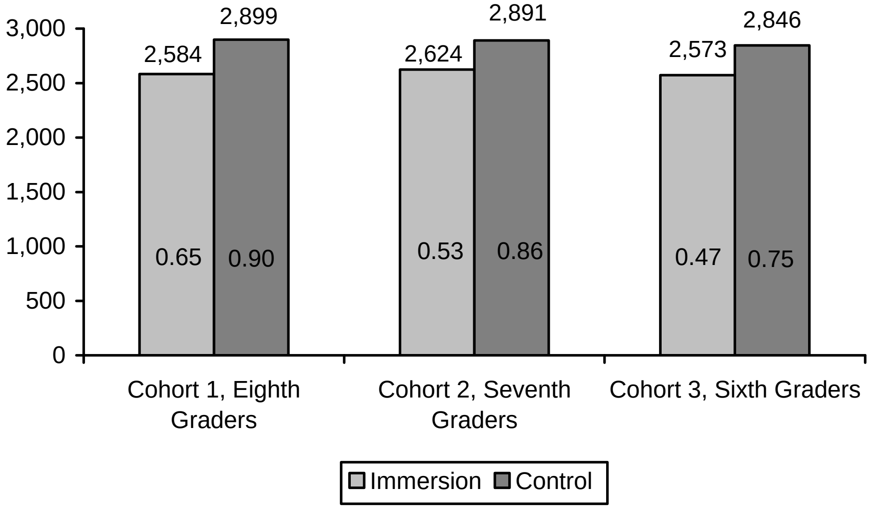

**Figure 5.4. Number of students disciplined and average number of disciplinary actions for Cohorts 1, 2, and 3 students who attended technology immersion and control schools.**

First, Cohort 1 eighth graders at immersion schools had significantly fewer disciplinary actions than control students ($t = 4.01$, $p < 0.001$). Specifically, 2,899 control-group students had an average of 0.90 disciplinary actions compared to 2,584 immersion students who had an average of 0.65 disciplinary events. Similarly, Cohort 2 seventh graders at immersion schools had significantly fewer disciplinary actions than students at control schools ($t = 5.83$, $p < 0.001$). Specifically, 2,899 control-group students had an average of 0.86 disciplinary actions compared to 2,624 immersion students who had an average of 0.53 disciplinary actions. Likewise, Cohort 3 students had significantly fewer disciplinary events ($t = 4.93$, $p < 0.001$). For Cohort 3, 2,846 sixth graders at control schools had an average of 0.75 disciplinary actions compared to 2,573 sixth graders at immersion schools who had 0.47 disciplinary actions, on average. Effect sizes for the mean differences between groups were small across cohorts (-0.11, -0.16, and -0.13, respectively).

Also note that the more conservative non-parametric Mann-Whitney U test showed significantly fewer disciplinary actions at immersion campuses (Table 5.7). For example, for Cohort 1, the mean rank for the immersion students, 2,688.41 was significantly less than the mean rank for control students, 2,789.77 ($z = 3.18$, $p = 0.001$). Similarly, for Cohorts 2 and 3, the mean ranks for immersion students were significantly less than the mean ranks for control students.

Overall, second-year findings on student discipline and behavior mirror results for the first and second project years. Evidence shows that sixth, seventh, and eighth graders attending technology immersion schools have fewer disciplinary referrals than their counterparts in control schools. Although the estimated size of differences between groups is considered statistically small, having fewer disciplinary actions per student in middle schools may have practically important benefits.

### *Student Attendance*

**School attendance rates (absolute values).** Another indicator of engagement is students' school attendance. Accordingly, we compared the annual attendance rates for Cohort 1 students for the year before project implementation and for three implementation years, Cohort 2 students for the year before implementation and for two implementation years, and Cohort 3 students for the year before implementation and after one implementation year (Table 5.7).

**Table 5.7. School Attendance Rates for Cohorts 1, 2, and 3 Students**

| | Immersion | | Control | | |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Difference |
| **Cohort 1 (8th)** | | | | | |
| 2003-04 | 97.23 | 3.86 | 97.54 | 3.05 | -0.31 |
| 2004-05 | 96.78 | 3.69 | 97.03 | 3.28 | -0.25 |
| 2005-06 | 96.07 | 4.66 | 96.84 | 3.53 | -0.77 |
| 2006-07 | 95.43 | 5.51 | 96.53 | 4.39 | -1.10 |
| **Cohort 2 (7th)** | | | | | |
| 2004-05 | 97.02 | 3.88 | 97.32 | 3.16 | -0.30 |
| 2005-06 | 96.42 | 4.20 | 96.91 | 3.61 | -0.49 |
| 2006-07 | 95.68 | 5.24 | 96.46 | 4.16 | -0.78 |
| **Cohort 3 (6th)** | | | | | |
| 2005-06 | 96.90 | 4.59 | 97.16 | 4.21 | -0.26 |
| 2006-07 | 96.05 | 5.33 | 96.77 | 4.77 | -0.72 |

Results for Cohort 1 students show that the average attendance rate of students in immersion schools was approximately 0.3 percentage point lower than the attendance rate of control students in the first year, and the attendance-rate gap increased incrementally to about 1.1 percentage points lower after three implementation years. Similarly, for Cohort 2, the average attendance rate of immersion students was about 0.3 percentage point lower than the attendance rate of control students in the year before implementation, and after two implementation years, the attendance-rate differential was about 0.8 percentage point lower. In the same way, the average attendance rate of Cohort 3 immersion students was about 0.3 percentage point lower than the control group prior to project implementation, and one year after implementation, the attendance rate of immersion students was 0.7 percentage point lower.

**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 Cohorts 1 and 2, we used three-level HLM growth models to examine changes in school attendance rates over time. For Cohort 3 students, we used a two-level HLM model to examine the effects of immersion on students' 2006-07 attendance rate. Table 5.8 presents the HLM statistics for each of the student cohorts.

**Table 5.8. Cohorts 1, 2, and 3: Immersion (Fixed) Effect Analyses of Student Attendance**

| Group | School-Level Analysis | Gamma Coefficient | *t* |
|---|---|---|---|
| **Cohort 1 (8th Graders)** | | | |
| **3-Level HLM Growth Model** | Initial attendance (2004) | 97.706 | 567.25*** |
| | Immersion | -0.045 | -0.19 |
| | School poverty | 2.230 | 3.56** |
| | Disadvantaged | -0.651 | -3.79*** |
| | Growth rate | -0.165 | -2.72* |
| | Immersion | -0.272 | -3.04** |
| | School poverty | -0.260 | -1.05 |
| | Disadvantaged | -0.119 | -2.03* |
| **Cohort 2 (7th Graders)** | | | |
| **3-Level HLM Model** | Initial attendance (2005) | 97.518 | 671.67*** |
| | Immersion | -0.262 | -1.41 |
| | School poverty | 1.550 | 2.71* |
| | Disadvantaged | -0.487 | -3.59** |
| | Growth rate | -0.120 | -1.38 |
| | Immersion | -0.249 | -2.28* |
| | School poverty | -0.437 | -1.59 |
| | Disadvantaged | -0.309 | -4.26*** |
| **Cohort 3 (6th Graders)** | | | |
| **2-Level HLM Model** | Intercept | 96.886 | 482.35*** |
| | Immersion[a] | -0.564 | -2.67* |
| | School poverty | 0.393 | 0.66 |
| | Prior attendance | 0.204 | 1.96* |
| | Disadvantaged | 0.382 | 1.58 |
| | Female | 0.262 | 1.53 |
| | Hispanic | -0.543 | -4.74*** |
| | African American | 0.622 | 17.00*** |

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

Contrary to expectations, results indicate that technology immersion had a significantly negative effect on students' school attendance. For Cohort 1 (eighth graders) estimated immersion effects on schools' adjusted average rates of attendance (controlling for student and school poverty) show that average 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 eighth grade (see Figure 5.5). The yearly estimated negative rate of change in attendance for immersion students (-0.44 percentage point) was greater than the annual change for control students (-0.17 percentage point). Thus, at the end of eighth grade, advantaged students in immersion schools had an estimated average attendance rate of 96.3% percent compared to 97.2% for control students, with the statistically significant difference favoring control students. 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 (-0.56 percentage point versus -0.28 point, respectively).

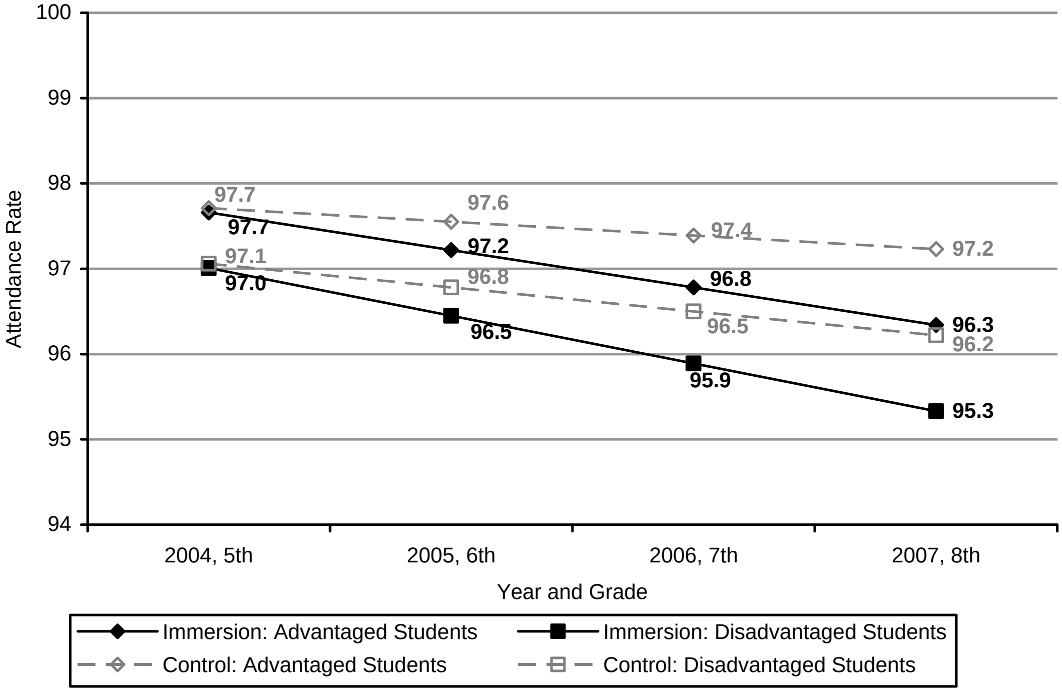

**Figure 5.5. Estimated attendance rates for Cohort 1 economically advantaged and disadvantaged students in immersion and control schools with average rates of school poverty.**

Similar to Cohort 1, average school attendance rates for economically advantaged Cohort 2 immersion and control-group students in schools with average rates of school poverty decreased as students advanced from fifth to seventh grade. The yearly estimated negative rate of change in attendance for immersion students (-0.37 percentage point) was greater than the annual change for control students (-0.12 percentage point). Thus, at the end of seventh grade, advantaged students in immersion schools had an estimated average attendance rate of 96.5% percent compared to 97.3% for control students, with the significant difference favoring control students. Attendance rates for economically disadvantaged students decreased at a faster pace, with yearly negative change rates for disadvantaged students in immersion schools greater than the rates for control students (-0.68 percentage point versus -0.43 point, respectively). Thus, by the end of seventh grade, economically disadvantaged students in immersion schools had an attendance rate of 95.4% compared to 96.2% for control students. HLM results for Cohort 3, similarly, showed that after controlling for school and student characteristics, immersion students attended school at a statistically lower rate than control students (-0.56 percentage point).

## Conclusions

In the third project year, we investigated the effects of technology immersion on students and learning for Cohort 1 (eighth graders), Cohort 2 (seventh graders), and Cohort 3 (sixth graders). After controlling for important school and student characteristics, data across three student cohorts confirm the hypothesized effects of immersion on some mediating variables, whereas outcomes for other variables are contrary to expectations. Key findings include the following.

- Across three cohorts, technology immersion positively affected students' classroom technology use (Classroom Activities) and interactions with peers (Small-Group Work). Students in immersion schools used various technology applications significantly more often in their core-subject classrooms than control students. They also had significantly more frequent opportunities to learn in small groups with their classmates.

- Across three cohorts, technology immersion positively affected students' Technology Proficiency, although some distinctions among Cohort 1 students emerged in the third year. Cohorts 2 and 3 immersion students grew in proficiency at a significantly faster rate or to a higher level than control students. For Cohort 1, economically disadvantaged immersion students grew in proficiency at a significantly faster rate than their more affluent peers. Certainly, technology immersion has substantially closed the technology equity gap for economically disadvantaged students.
- Cohorts 1 and 2 technology immersion students, compared to control-group students, reported mounting Technical Problems using computers over time, with the growth in problems statistically significant for Cohort 1 eighth graders. Similarly, Cohort 3 immersion students reported having technical problems using computers significantly more often than control students.
- Across three cohorts, technology 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 eighth grade they reported significantly less self-directed learning behaviors. Likewise, immersion and control-group students expressed similar levels of school satisfaction, with both groups reporting significantly lower levels of school satisfaction as they progressed to higher grade levels.
- Across three cohorts, technology immersion positively affected student discipline and behavior. Students in immersion schools, on average, had proportionately fewer behavioral and disciplinary problems that removed them from the regular academic program than their counterparts in control schools.
- Contrary to expectations, results indicated that technology immersion had a negative effect on students' school attendance. Across three cohorts, estimated attendance rates for immersion students were significantly lower than attendance rates for control-group students. Thus, students in immersion schools attended school less regularly than control students, and their school attendance declined each implementation year.

# 6. Effects of Technology Immersion on Student Achievement

The Texas Technology Immersion project 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 in fully immersed schools will experience school and classroom conditions that promote more individualized learning, 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 third year of the technology immersion project, as detailed in previous report chapters, we have noted teachers' substantial growth across years in technology proficiency and the frequency of classroom technology use, as well as improvements in students' technology proficiency and use, and their school behavior. The following sections present academic achievement results for Cohorts 1, 2, and 3 students who were enrolled continuously in the 21 immersion and 21 control schools through TAKS testing in April 2007.

## Texas Assessment of Knowledge and Skills

### Passing Standards and Scale Scores

The TAKS is Texas' criterion-referenced assessment that measures students' mastery of the state's content standards, the Texas Essential Knowledge and Skills (TEKS). At the middle school, TAKS assesses reading and mathematics at grades 6, 7, and 8, writing at grade 7, and science and social studies at grade 8. 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 phased-in increasingly rigorous passing standards on the TAKS. In 2004-05, passing standards recommended for reading, mathematics, writing, social studies, and grade 5 science by the State Board of Education panel were fully implemented. For the newer grade 8 science test, the panel-recommended standard must be met in 2007-08. For this study, all TAKS scores reported are based on panel-recommended standards.

## Standard Scores

In addition to the scores provided by the Texas Education Agency (TEA), researchers generated standard scores that 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.

One characteristic of *z* scores is that about half of the scores are negative, and negative scores may be difficult to fully understand. To overcome this limitation, we have transformed students' *z* scores into normalized scores, or *T* scores. *T* scores are scores with a mean of 50 and a standard deviation of 10. Thus, a student who scores at the state average will have a TAKS *T* score of 50. A student who has a score of 60 will be one standard deviation above the state average, and a student who has a score of 40 will be one standard deviation below the state average.

# Progress in Meeting TAKS Standards

## TAKS Reading

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 students in immersion and control schools for TAKS reading.

**Table 6.1. TAKS Passing and Commended Performance Rates for Reading**

| TAKS Test | Group | N | 2004 Percent | 2005 Percent | 2006 Percent | 2007 Percent | *Baseline to 2007 Difference* |
|---|---|---|---|---|---|---|---|
| **Met Standard** | | | | | | | |
| **Cohort 1** | Immersion | 1,380 | *68.4* | 76.4 | 73.6 | 86.1 | 17.7 |
| Grade 5 to 8 | Control | 1,613 | *73.8* | 82.5 | 78.4 | 88.1 | 14.3 |
| **Cohort 2** | Immersion | 1,546 | -- | *67.1* | 87.6 | 80.9 | 13.8 |
| Grade 5 to 7 | Control | 1,725 | -- | *73.7* | 91.2 | 84.1 | 10.4 |
| **Cohort 3** | Immersion | 1,778 | -- | -- | *74.0* | 87.0 | 13.0 |
| Grade 5 to 6 | Control | 1,991 | -- | -- | *80.0* | 91.6 | 11.6 |
| **Commended Performance** | | | | | | | |
| **Cohort 1** | Immersion | 1,380 | *19.7* | 29.3 | 17.1 | 35.1 | 15.4 |
| Grade 5 to 8 | Control | 1,613 | *23.2* | 35.6 | 18.9 | 40.8 | 17.6 |
| **Cohort 2** | Immersion | 1,546 | -- | *17.5* | 29.4 | 21.4 | 3.9 |
| Grade 5 to 7 | Control | 1,725 | -- | *19.0* | 33.8 | 20.5 | 1.5 |
| **Cohort 3** | Immersion | 1,778 | -- | -- | *18.3* | 39.5 | 21.3 |
| Grade 5 to 6 | Control | 1,991 | -- | -- | *20.4* | 47.1 | 26.7 |

*Source:* Analysis of individual student data from TEA.
*Note*. The 2004 passing rates are based on 2005 standards. Students in 21 immersion and 21 control schools that had TAKS scores and attended the same school across years. Italic text denotes baseline scores.

Results show that Cohorts 1, 2, and 3 students at immersion schools had slightly lower passing rates in spring 2007 for TAKS reading than students at control campuses. However, students at immersion campuses had greater baseline-to-2007 passing increases. For Cohort 1, TAKS-score comparisons between 2004 (5th grade baseline) and 2007 (8th grade) revealed slightly larger reading gains for the immersion group (17.7 percentage points versus 14.3 points for the control group). Similarly, for

Cohort 2, the TAKS passing rate difference between 2005 (5th grade baseline) and 2007 (7th grade) favored students at immersion schools (13.8 percentage points versus 10.4 points for control students). Likewise, passing rate comparisons between 2006 (5th grade baseline) and 2007 (6th grade) favored Cohort 3 students at immersion schools (13.0 percentage points versus 11.6 points for control students).

For commended performance, Cohorts 1 and 3 students at control schools had higher 2007 achievement rates and larger baseline-to-2007 gains than immersion students. Conversely, Cohort 2 students at immersion schools had a slightly higher commended performance rate and showed larger gains.

## TAKS Mathematics

Similar to reading, results for TAKS mathematics show that Cohorts 1, 2, and 3 students at immersion schools had slightly lower TAKS mathematics passing rates in spring 2007 than students at control campuses (Table 6.2). However, TAKS-score comparisons across years revealed slightly smaller TAKS mathematics decreases for each of the immersion groups.

**Table 6.2. TAKS Passing and Commended Performance Rates for Mathematics**

| TAKS Test | Group | N | 2004 Percent | 2005 Percent | 2006 Percent | 2007 Percent | *Baseline to 2007 Difference* |
|---|---|---|---|---|---|---|---|
| **Met Standard** | | | | | | | |
| **Cohort 1** | Immersion | 1,397 | *70.7* | 62.3 | 65.7 | 70.7 | 0.0 |
| Grade 5 to 8 | Control | 1,616 | *73.2* | 68.4 | 68.5 | 71.5 | -1.7 |
| **Cohort 2** | Immersion | 1,560 | -- | *73.3* | 72.4 | 72.2 | -1.1 |
| Grade 5 to 7 | Control | 1,750 | -- | *79.3* | 74.9 | 73.0 | -6.3 |
| **Cohort 3** | Immersion | 1,782 | -- | -- | *77.7* | 72.5 | -5.2 |
| Grade 5 to 6 | Control | 2,031 | -- | -- | *84.0* | 77.2 | -6.8 |
| **Commended Performance** | | | | | | | |
| **Cohort 1** | Immersion | 1,397 | *24.2* | 19.8 | 11.0 | 15.7 | -8.5 |
| Grade 5 to 8 | Control | 1,616 | *24.6* | 21.8 | 9.7 | 13.8 | -10.8 |
| **Cohort 2** | Immersion | 1,560 | -- | *22.6* | 22.3 | 15.9 | -6.7 |
| Grade 5 to 7 | Control | 1,750 | -- | *25.3* | 22.6 | 12.0 | -13.3 |
| **Cohort 3** | Immersion | 1,782 | -- | -- | *31.5* | 27.6 | -3.9 |
| Grade 5 to 6 | Control | 2,031 | -- | -- | *36.4* | 27.5 | -8.9 |

*Source:* Analysis of individual student data from TEA.
*Note*. The 2004 passing rates are based on 2005 standards. Students in 21 immersion and 21 control schools that had TAKS scores and attended the same school across years. Italic text denotes baseline scores.

Overall, students had greater difficulty meeting commended standards for mathematics compared to reading. However, comparison-group trends showed that immersion students had generally higher TAKS mathematics commended performance rates and smaller losses. Baseline-to-2007 differences for commended performance favored Cohort 1 eighth graders in immersion schools (-8.5 percentage points versus -10.8 points for control students), Cohort 2 seventh graders (-6.7 percentage points versus -13.3 points), and Cohort 3 sixth graders (-5.2 percentage points versus -6.8 points).

## TAKS Social Studies, Science, and Writing

The TAKS reading and mathematics tests are administered annually, whereas TAKS tests are administered periodically in other subject areas. In the third year, Cohort 1 eighth graders completed TAKS social studies and science assessments, while Cohort 2 seventh graders completed TAKS writing. Baseline measures were available for TAKS science in grade 5 and writing in grade 4. There was no pre-measure for TAKS social studies.

Results for TAKS social studies in Table 6.3 show that Cohort 1 students at both immersion and control schools had similar TAKS passing rates for social studies in 2007, but commended performance rates were slightly higher for students at immersion campuses (28.5% versus 26.7%). Conversely, Cohort 1 students at immersion schools had slightly lower TAKS passing rates for science in 2007 (65.5%) than control students (67.6%) but nearly identical baseline to 2007 passing rate decreases (-2.2 and -2.6 percentage points, respectively). Control students also achieved 2007 commended performance in science at a slightly higher rate than immersion students and had a baseline to 2007 gain rather than a loss.

**Table 6.3. Cohort 1 (Eighth Graders in 2006-07):**
**TAKS Passing and Commended Performance Rates for Social Studies and Science**

| TAKS Test | Group | N | 2004 Grade 5 Percent | 2007 Grade 8 Percent | *Baseline to 2007 Difference* |
|---|---|---|---|---|---|
| **Met Standard** | | | | | |
| Social Studies | Immersion | 1,459 | -- | 85.6 | -- |
| | Control | 1,710 | -- | 86.0 | -- |
| Science | Immersion | 1,367 | *67.7* | 65.5 | -2.2 |
| | Control | 1,600 | *70.2* | 67.6 | -2.6 |
| **Commended Performance** | | | | | |
| Social Studies | Immersion | 1,459 | -- | 28.5 | -- |
| | Control | 1,710 | -- | 26.7 | -- |
| Science | Immersion | 1,367 | *14.0* | 12.3 | -1.7 |
| | Control | 1,600 | *12.3* | 14.0 | 1.7 |

*Source:* Analysis of individual student data from TEA.
*Note*. The 2004 passing rates are based on 2005 standards. Students had TAKS scores and attended the same school across years. Italic text denotes baseline scores.

Table 6.4 shows that Cohort 2 students at immersion schools had slightly lower TAKS passing rates for writing in 2007 than control students, and immersion students' TAKS-score gains between 2004 (4th grade baseline) and 2007 (7th grade) were slightly smaller. Control students also achieved commended performance in writing at a higher rate and had larger gains than immersion students (12.4 percentage points versus 10.7 points).

**Table 6.4. Cohort 2 (Seventh Graders in 2006-07):**
**TAKS Passing and Commended Performance Rates for Writing**

| TAKS Test | Group | N | 2004 Grade 4 Percent | 2007 Grade 7 Percent | *Baseline to 2007 Difference* |
|---|---|---|---|---|---|
| **Met Standard** | | | | | |
| Writing | Immersion | 1,457 | *92.2* | 94.6 | 2.4 |
| | Control | 1,631 | *92.8* | 95.7 | 2.9 |
| **Commended Performance** | | | | | |
| Writing | Immersion | 1,457 | *18.0* | 28.7 | 10.7 |
| | Control | 1,631 | *19.0* | 31.4 | 12.4 |

*Source:* Analysis of individual student data from TEA.
*Note*. The 2004 passing rates are based on 2005 standards. Students had TAKS scores and attended the same school across years. Italic text denotes baseline scores.

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

## Effects of Immersion on Academic Achievement

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

- Cohort 1, before and after three years of project implementation (sixth to eighth grade),
- Cohort 2, before and after two implementation years (sixth to seventh grade), and
- Cohort 3, before and after one implementation year (sixth grade).

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

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

### TAKS Reading

#### *Cohorts 1 and 2*

TAKS reading achievement growth trajectories were estimated for Cohorts 1 and 2 students in immersion and control schools. Three-level HLM growth models examined the extent to which student achievement varied across time, students, and schools. Given the complexity of interpreting growth models, we constrained our final models to include school and student predictors that exhibited strong associations with achievement (i.e., school and student poverty). In the HLM growth model, level 1 is a repeated-measures model (i.e., TAKS assessment time within students) that captures the key features of growth (e.g., initial status, rate of change). Time is the point at which students completed assessments each spring (Cohort 1, 0 = 2004, 1 = 2005, 2 = 2006, 3 = 2007; Cohort 2, 0 = 2005, 1 = 2006, 2 = 2007).

The between-students model (level 2) modeled differences between students in features of growth (e.g., initial status, rate of change), after adjusting for students' economic status (1 if economically disadvantaged [i.e., eligible for the federal free- and reduced-price lunch program], 0 if not). At the school level (level 3), we examined how students' initial status and growth varied across schools as a function of school-level random effects, as well as school conditions, including group membership

(1 for immersion, 0 for the control group) and school poverty (percentage of economically disadvantaged students attending a school). School poverty rates ranged from 31% to 100%, with a mean of 69.8%. 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.

Separate HLM growth models were used to determine the effects of immersion on Cohort 1 and Cohort 2 students' growth in TAKS reading achievement (Table 6.5). Growth models estimated school mean rates of change for immersion and control students, as well as the separate effects of student economic disadvantage and the school poverty concentration on reading. Analyses for Cohort 1 involved 1,380 immersion and 1,613 control students. Comparison groups had nearly equivalent proportions of students included in longitudinal analyses (58.9% for immersion and 57.9% for control). Cohort 2 analyses involved 1,546 immersion and 1,725 control students. As with Cohort 1, analyses involved nearly equal proportions of students across groups (58.3% for immersion and 60.7% for control).

**Table 6.5. HLM Statistics for Cohort 1 and Cohort 2 Students: Effects of Immersion on TAKS Reading Achievement Growth Rates**

| | Cohort 1 (Eight Graders) *N* = 2,993 | | Cohort 2 (Seventh Graders) *N* = 3,271 | |
|---|---|---|---|---|
| Dependent variable and predictor | Gamma Coefficient | *t*-value | Gamma Coefficient | *t*-value |
| Initial mean status (2004/2005 TAKS *T* score) | 54.002 | 76.89*** | 52.770 | 100.87*** |
| Immersion[a] | -1.346 | -1.89† | -0.488 | -0.81 |
| School poverty | -6.504 | -4.49*** | -8.049 | -5.77*** |
| Economic disadvantage | -6.170 | -9.40*** | -5.591 | -9.33*** |
| Growth rate | -0.369 | -2.86** | -0.155 | -0.85 |
| Immersion[a] | 0.212 | 1.45 | 0.388 | 1.66 |
| School poverty | 0.860 | 1.75† | 0.905 | 1.30 |
| Economic disadvantage | 0.536 | 4.07*** | 0.283 | 1.56 |

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

[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 = 1.30).

As Table 6.5 shows, the initial mean TAKS reading status for the Cohort 1 reference group (an economically advantaged eighth grader in a control school with an average level of school poverty) is estimated at 54.00 (the mean 2004 TAKS reading *T* score). The coefficient representing immersion (-1.346) shows that students in immersion schools had lower initial TAKS reading *T* scores (52.66) than control students. Considering that differences among schools in students' initial achievement may be related to subsequent rates of change, we used statistical tests to establish that those differences did not affect the estimations of student growth. Coefficients for initial status also showed that economically disadvantaged students and students attending schools with above average levels of poverty started behind their more advantaged counterparts in reading ability (-6.17 and -6.50 *T*-score points, respectively).

After controlling for student and school levels of poverty, results show there was no statistically significant effect of immersion on Cohort 1 students' growth rate for TAKS reading. Reading achievement for advantaged students in control schools (with average poverty) decreased by -0.37 *T*-score point per year (significantly negative coefficient, -0.369). The positive coefficient for immersion (0.212) indicates that reading scores for advantaged students in immersion schools (with average poverty) decreased at a slower rate (-0.16 *T*-score point per year) compared to control-group students (-0.369 + 0.212 = -0.157). Economically disadvantaged eighth graders at both immersion and control schools grew in reading achievement at significantly faster rates than their more advantaged peers (0.38 *T*-score point per year for immersion and 0.17 *T*-score point for control students).

TAKS reading outcomes for Cohort 2, similarly, showed no statistically significant effect of immersion on seventh graders' reading achievement. The reading *T* scores of advantaged seventh graders in control schools with average poverty decreased (-0.16 *T*-score point per year), while the scores for advantaged students in immersion schools increased (0.23 *T*-score point per year). Economically disadvantaged seventh graders at both immersion and control schools grew in reading at a slightly faster rate than their more advantaged students.

Figures 6.1 and 6.2 illustrate the estimated mean TAKS reading growth trajectories for advantaged and disadvantaged Cohort 1 and Cohort 2 students, respectively, by school comparison group.

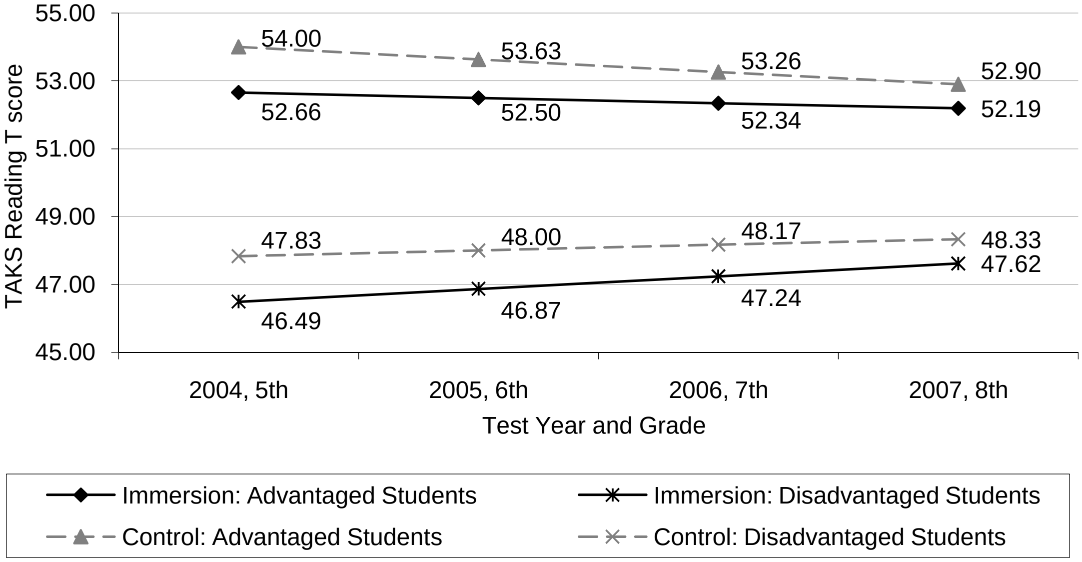

**Figure 6.1. Estimated mean TAKS reading achievement growth trajectories for Cohort 1 economically advantaged and disadvantaged student groups in immersion and control schools. Differences between immersion and control groups are statistically insignificant.**

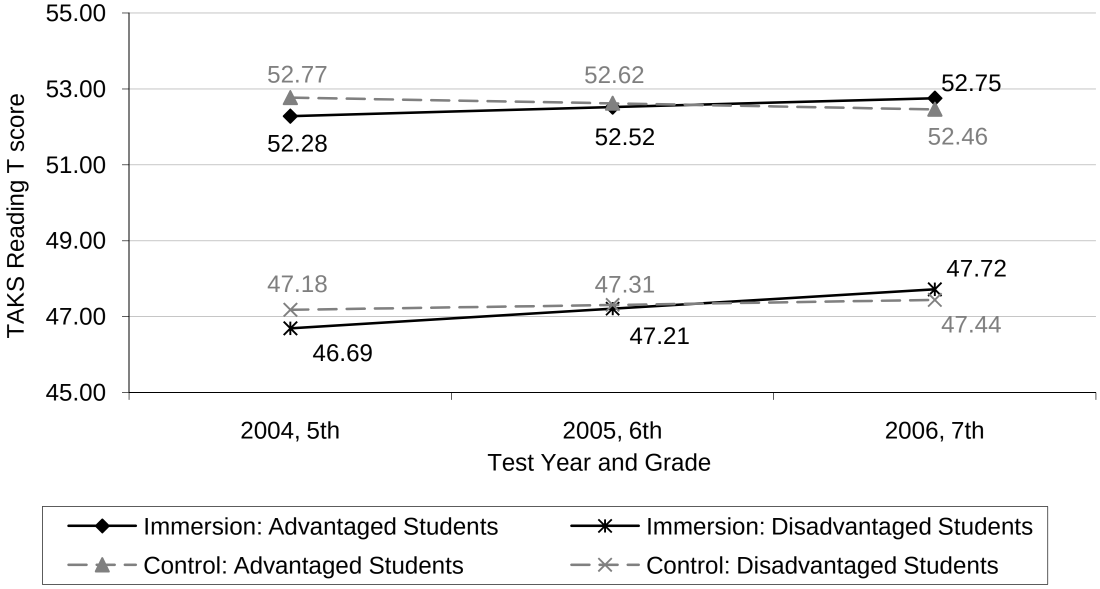

**Figure 6.2. Estimated mean TAKS reading achievement growth trajectories for Cohort 2 economically advantaged and disadvantaged student groups in immersion and control schools. Differences between immersion and control groups are statistically insignificant.**

### *Cohort 3*

We analyzed the effects of immersion on Cohort 3 students' TAKS reading *T* scores using a two-level HLM model (see Table 6.6). In the student-level model (level 1), 2007 TAKS reading *T* scores were regressed on 2006 reading 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 achievement than control schools, after controlling for initial achievement, student demographic characteristics, and school poverty. The immersion variable identified the comparison groups (1 = immersion, 0 = control). School poverty was a continuous variable depicting the concentration of economically disadvantaged students in a school. Analyses involved 1,778 immersion students and 1,991 control students, with similar proportions of students included in analyses (68.5% and 70.1%, respectively).

**Table 6.6. HLM Statistics for Cohort 3 (Sixth Graders): Effect of Immersion (Fixed) on TAKS Reading Achievement**

| Dependent variable and predictor | TAKS Reading *N* = 3,769 Gamma Coefficient | *t*-value |
|---|---|---|
| Intercept (2007 TAKS *T* score) | 49.140 | 145.71*** |
| Immersion | 0.082 | 0.33 |
| School poverty | 1.591 | 1.82 |
| Female | 1.385 | 7.41*** |
| African American | -1.486 | -4.23*** |
| Hispanic | -1.075 | -3.88** |
| Economic disadvantage | -0.539 | -2.81** |
| 2006 TAKS *T* score | 0.523 | 34.72*** |

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

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 statistically significant differences in the 2007 TAKS reading *T* scores for students in immersion and control schools. Similar to Cohorts 1 and 2, the immersion coefficient was positive (about 0.08 *T*-score points). Students' individual characteristics, however, were the strongest predictors of reading achievement. Female students had significantly higher TAKS reading *T* scores than males, whereas African American, Hispanic, and economically disadvantaged students had significantly lower TAKS reading scores than other students.

## TAKS Mathematics

### *Cohorts 1 and 2*

Similar to reading, we estimated the TAKS mathematics achievement growth trajectories for Cohorts 1 and 2 students in immersion and control schools (Table 6.7). Three-level HLM growth models were used to examine the extent to which mathematics achievement varied across time (the point at which students completed TAKS assessments each spring), students, and schools. Results for Cohort 1 students show that control students initially had an estimated mean mathematics *T* score of 53.02, whereas immersion student began with a lower estimated mathematics score (51.82). Economically disadvantaged students and students attending schools with above average levels of poverty started significantly behind their more advantaged peers in math ability (-4.487 and -4,724 *T*-score points, respectively).

**Table 6.7. HLM Statistics for Cohort 1 and Cohort 2 Students: Effects of Immersion on TAKS Mathematics Achievement Growth Rates**

| | Cohort 1 (Eight Graders) *N* = 3,013 | | Cohort 2 (Seventh Graders) *N* = 3,310 | |
|---|---|---|---|---|
| Dependent variable and predictor | Gamma Coefficient | *t*-value | Gamma Coefficient | *t*-value |
| Initial mean status (2004/2005 TAKS *T* score) | 53.019 | 70.83*** | 52.306 | 95.59*** |
| Immersion$^{a}$ | -1.201 | -1.36 | -1.029 | -1.54 |
| School poverty | -4.724 | -2.50* | -4.373 | -2.39* |
| Economic disadvantage | -4.487 | -8.60*** | -4.492 | -7.80*** |
| Growth rate | -0.181 | -1.15 | -0.444 | -1.65 |
| Immersion$^{a}$ | 0.582 | 1.95$^{\dagger}$ | 0.708 | 1.78$^{\dagger}$ |
| School poverty | 1.488 | 1.67 | 0.317 | 0.31 |
| Economic disadvantage | 0.025 | 0.29 | 0.044 | 0.24 |
| Economic x Immersion | -0.408 | -1.90$^{\dagger}$ | -- | -- |

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

After controlling for student and school levels of poverty, the effect of immersion on students' growth rate for TAKS mathematics scores was statistically significant at the $p < .10$ level. Estimated mathematics achievement for economically advantaged students in immersion schools (with average poverty) increased by about 0.40 *T*-score point per year (coefficient of 0.582), while the math scores of their control-group counterparts decreased by about 0.18 *T*-score point per year (coefficient of -0.181). A significant interaction effect between students' socioeconomic status and immersion was also detected. Economically disadvantaged students in immersion schools grew in mathematics achievement at a significantly slower rate (about 0.02 T-score point per year) than more advantaged immersion students (about 0.40 point per year). In contrast, economically advantaged and disadvantaged control students had comparably negative growth trends (-0.18 and -0.16 *T*-score point, respectively). Figure 6.3 illustrates the estimated mean TAKS mathematics growth trajectories for Cohort 1 advantaged and disadvantaged students at immersion and control schools.

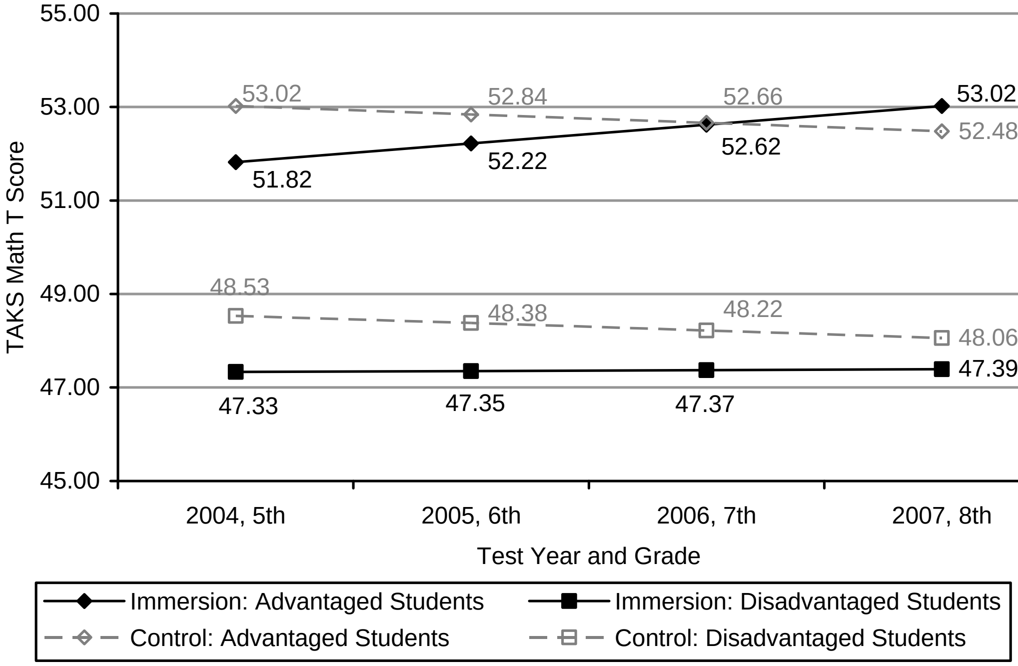

**Figure 6.3. Significant immersion effect and cross-level interaction between immersion and economically disadvantaged status (*p < .10)* for Cohort 1 TAKS mathematics achievement (in schools with average levels of poverty).**

TAKS mathematics outcomes for Cohort 2 revealed a statistically significant effect of immersion on seventh graders' math achievement for both advantaged and disadvantaged students at the $p < .10$ level. The mathematics *T* scores of advantaged seventh graders in immersion schools (with average poverty) increased (0.26 *T*-score point per year), while the scores for advantaged students in control schools decreased (-0.44 *T*-score point per year). Similarly, the math scores for economically disadvantaged seventh graders at immersion schools increased (0.30 *T*-score point per year), whereas disadvantaged control-group students had a negative growth trend (- 0.40 *T*-score point per year). Figure 6.4 illustrates the estimated mean TAKS mathematics growth trajectories for Cohort 2 advantaged and disadvantaged students at immersion and control schools.

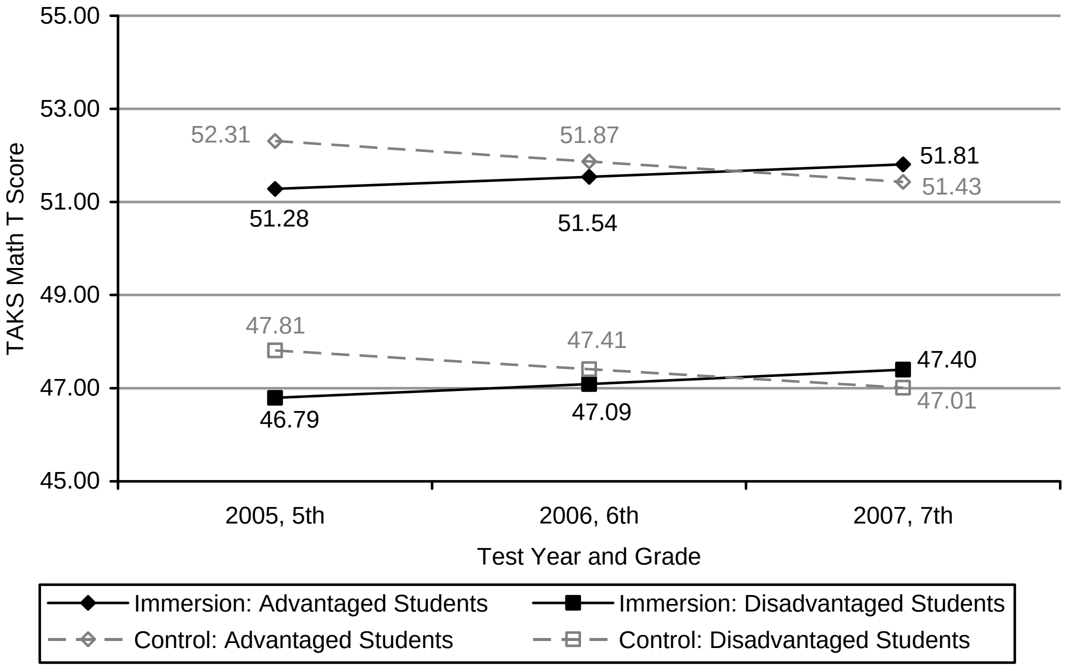

**Figure 6.4. Significant immersion effect (*p < .10)* for Cohort 2 students' TAKS mathematics achievement (in schools with average levels of poverty).**

### *Cohort 3*

We analyzed the effects of immersion on Cohort 3 sixth graders' mathematics scores using a two-level HLM model (Table 6.8). In the student-level model, 2007 TAKS mathematics *T* scores were regressed on 2006 mathematics scores, gender, minority status, and economic status. A school-level model estimated whether immersion schools had higher TAKS achievement scores than control schools, after controlling for initial achievement, student demographic characteristics, and school poverty (percentage of economically disadvantaged students). Analyses involved 1,782 immersion students and 2,031 control students, with similar proportions of students included in analyses across groups.

**Table 6.8. HLM Statistics for Cohort 3 (Sixth Graders):**
**Effect of Immersion (Fixed) on TAKS Mathematics Achievement**

| | TAKS Mathematics *N* = 3,813 | |
|---|---|---|
| Dependent variable and predictor | Gamma Coefficient | *t*-value |
| Intercept (TAKS *T* score) | 48.799 | 99.43*** |
| Immersion | 0.282 | 0.44 |
| School poverty | 0.265 | 0.16 |
| Female | 0.944 | 4.05*** |
| African American | -1.309 | -3.69** |
| Hispanic | -0.486 | -1.99* |
| Economic disadvantage | -1.064 | -4.23*** |
| 2006 TAKS *T* score | 0.608 | 28.98*** |
| Pretest x Immersion | 0.082 | 3.41** |

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

TAKS mathematics outcomes for sixth graders reported in Table 6.8 show that after controlling for students' prior TAKS achievement, demographic characteristics, and the level of school poverty, there was no significant main effect of immersion on sixth graders' 2007 TAKS mathematics *T* scores. The immersion effect was positive but not by a significant margin (about 0.28 *T*-score point). However, a significant interaction effect was detected, which acted through the TAKS pretest score. Thus, the magnitude of the immersion effect depended upon students' prior math achievement. Other factors being equal, having higher TAKS 2006 pretest scores predicted larger gaps in the posttest mathematics scores (2007) favoring immersion students. Thus, for TAKS mathematics, immersion had a stronger and statistically significant effect on higher achieving students ($p < .01$).

Figure 6.3 illustrates the interaction effect for average immersion and control students. As an example, students in immersion schools with pretest TAKS mathematics *T* scores near 30.0 would have posttest TAKS scores about 1.30 *T*-score points below control students. On the other hand, immersion students who had pretest mathematics *T* scores of about 60.0 would have posttest scores nearly 2.00 *T*-score points higher than control students.

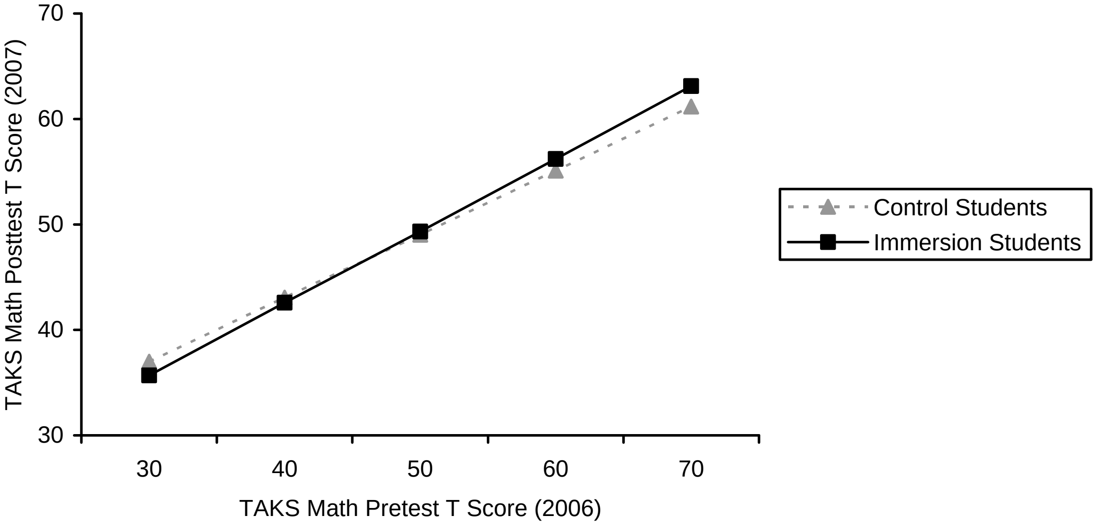

**Figure 6.5. Significant immersion effect (*p* <.01) on Cohort 3 TAKS mathematics achievement, which acts through the pretest score.**

## TAKS Social Studies and Science

### *Cohort 1*

Cohort 1 students also completed TAKS science and social studies assessments in spring 2007. For science, eighth graders completed a baseline measure as fifth graders in 2004. The TAKS social studies assessment is administered for the first time in eighth grade. Since there was no baseline measure, we used students' 2006 TAKS reading score as a control for academic achievement. The effects of immersion on Cohort 1 students' science and social studies scores were analyzed using two-level HLM models (see Table 6.9). In the student-level model (level 1), students' 2007 *T* scores were regressed on students' baseline scores, gender, minority status, and economic status. A school-level model (level 2) was used to determine whether students in immersion schools had higher TAKS science and social studies scores than control-group students in spring 2007, after adjusting for initial achievement, student demographic characteristics, and school poverty. The immersion variable identified the comparison groups (a value of 1 for an immersion school and 0 for control). School poverty was a continuous variable, with a mean of 69.8%, indicating the percentage of economically disadvantaged students in a school. Analyses for TAKS science involved 1,367 immersion students and 1,600 control students, with similar proportions of students included in analyses across groups (58.3% for immersion and 57.4% for control). Analyses for TAKS social studies involved 1,443 immersion students and 1,700 control students, with similar proportions of students included in analyses across groups (61.6% for immersion and 61.0% for control).

**Table 6.9. HLM Statistics for Cohort 1 (Eighth Graders): Effect of Immersion (Fixed) on TAKS Science and Social Studies Achievement**

| | TAKS Science *N* = 2,967 | | TAKS Social Studies *N* = 3,143 | |
|---|---|---|---|---|
| | Gamma Coefficient | *t*-value | Gamma Coefficient | *t*-value |
| Intercept (TAKS *T* score) | 52.269 | 91.89*** | 49.525 | 45.93*** |
| Immersion | -0.238 | -0.36 | 0.574 | 0.95 |
| School poverty | 0.167 | 0.09 | 4.607 | 2.78** |
| Female | -1.203 | -5.90*** | -2.537 | -10.32*** |
| African American | -2.052 | -2.57* | -1.851 | -5.31*** |
| Hispanic | -1.712 | -4.47*** | -2.033 | -3.99*** |
| Economic disadvantage | -1.518 | -4.41*** | -1.614 | -4.35*** |
| 2004/2006 TAKS *T* score [a] | 0.681 | 23.72*** | 0.539 | 35.30*** |
| Pretest x Immersion | -0.084 | -1.90† | -- | |

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

[a] The pre-measure for science is the 2004 TAKS science score; the pre-measure for TAKS social studies is the 2006 TAKS reading score.

Science outcomes for Cohort 1 eighth graders show that after controlling for students' prior TAKS achievement, demographic characteristics, and the level of school poverty, there was no significant main effect of immersion on eighth graders' 2007 TAKS science *T* scores. In fact, the immersion effect was negative (-0.24 *T*-score point). Additionally, a significant interaction effect was detected, which acted through the TAKS 2004 science pretest score. The magnitude of the immersion effect depended upon students' prior achievement. Other factors being equal, having higher TAKS science pretest scores (2004) predicted larger gaps in the 2007 science scores favoring control students. Thus, for higher achieving students in immersion schools, there was a significantly negative effect on science achievement (a -0.084 *T*-score point decrease for each *T*-point increase in prior science achievement).

Results for TAKS social studies, showed that after controlling for students' 2006 TAKS reading achievement, demographic characteristics, and the level of school poverty, there was no statistically significant difference between the 2007 TAKS social studies *T* scores for immersion and control students. In contrast to science, the immersion effect was positive (0.57 *T*-score point) but not by a statistically significant margin.

Across both immersion and control schools, economically disadvantaged students had significantly lower TAKS science scores (-1.52 *T*-score points) and social studies scores (-1.61 *T*-score points) than their more affluent counterparts. And, minority students (African American and Hispanic) had significantly lower scores than other students. Unexpectedly, female students had significantly lower science and social studies scores than males (1.20 *T*-score point and 2.54 *T*-score point, respectively). This contrasts with prevailing trends showing that females outperform males on TAKS reading and mathematics assessments.

## TAKS Writing

### *Cohort 2*

Cohort 2 students completed the TAKS writing assessment as fourth graders in 2004 and again as seventh graders in 2007. We used a two-level HLM model to estimate the effects of immersion on students' writing scores (see Table 6.10). In the student-level model (level 1), students' 2007 writing *T* scores were regressed on 2004 writing scores (data from two years prior to students' involvement in the immersion project), gender, minority status, and economic status. A school-level model (level 2) predicted whether students in immersion schools had higher 2007 TAKS writing *T* scores than control-group students, after adjusting for initial achievement, student demographic characteristics, and school poverty. HLM analyses involved 1,457 immersion students and 1.631 control students.

**Table 6.10. HLM Statistics for Cohort 2 (Seventh Graders): Effects of Immersion (Fixed) on TAKS Writing Achievement**

| Dependent variable and predictor | TAKS Writing *N* = 3,088 | |
|---|---|---|
| | Gamma Coefficient | *t*-value |
| Intercept (TAKS *T* score) | 51.181 | 100.44*** |
| Immersion | -0.283 | -0.66 |
| School poverty | 0.315 | 0.24 |
| Female | 1.409 | 5.94*** |
| African American | -1.141 | -2.95** |
| Hispanic | -1.355 | -4.47*** |
| Economic disadvantage | -1.210 | -3.36** |
| Spring 2004 *T* score | 0.453 | 28.59*** |

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

Results for Cohort 2 students show that after controlling for students' pretest writing scores, student demographic characteristics (gender, ethnicity, economic status), and campus poverty level, there was no statistically significant difference in the 2007 TAKS writing *T* scores for students in immersion and control schools. The immersion effect on writing was negative (about -0.28 *T*-score point lower than for control-group students). Across both immersion and control schools, the demographic characteristics of students were strongly associated with TAKS writing achievement. Female students had significantly higher writing scores than males (about 1.41 *T*-score points), African American and Hispanic students had significantly lower writing scores than other students (-1.14 and -1.36 points, respectively), and economically disadvantaged students had significantly lower scores than their more affluent peers (-1.21 *T*-score points).

## Conclusions

In the third project year, we examined the effects of immersion on Cohort 1 students (eighth graders who attended schools for three years), Cohort 2 students (seventh graders who attended schools for two years), and Cohort 3 students (sixth graders who attended one school year). Key findings are the following.

- **TAKS reading**. After controlling for student and school poverty, there were no statistically significant effects of immersion on the TAKS reading growth rates for either Cohort 1 or Cohort 2 students. The immersion effects were positive but not by significant margins. Across both student cohorts, positive mean growth trajectories showed that economically disadvantaged students grew in reading achievement at faster rates than their more affluent peers. This growth provided a substantial boost in reading achievement for economically disadvantaged immersion students in Cohorts 1 and 2.

For Cohort 3, after controls for students’ prior achievement, demographic characteristics, and school poverty, there was no statistically significant effect of immersion on students’ 2007 TAKS reading *T* scores. Similar to the other cohorts, the immersion coefficient for reading was positive.

- **TAKS mathematics.** After controlling for student and school poverty, technology immersion had a statistically significant effect on TAKS mathematics growth rates for both Cohorts 1 and 2 students. The TAKS mathematics scores of immersion students increased across years, whereas scores for control students decreased. For Cohort 1, a significant interaction effect revealed that economically advantaged students in immersion schools grew at a significantly faster rate than disadvantaged students. For Cohort 2, economically advantaged and disadvantaged immersion students had similarly positive TAKS mathematics growth trends that significantly outpaced their control-group counterparts.

  For Cohort 3, after controlling for students’ prior achievement, demographic characteristics, and school poverty, there was a statistically significant effect of immersion that acted through students’ pretest scores. As TAKS pretest scores increased, the mathematics achievement gap for 2007 TAKS scores favoring immersion students over control widened. Thus, immersion had a significantly positive effect on mathematics scores for higher achieving sixth graders.

- **TAKS social studies.** After controlling for Cohort 1, eighth graders’ reading achievement (seventh grade), demographic characteristics, and school poverty, there was no statistically significant effect of immersion on 2007 TAKS social studies scores. The immersion effect was positive but not by a statistical margin.

- **TAKS science.** After controlling for prior science achievement, demographic characteristics, and school poverty, there was no statistically significant effect of immersion on Cohort 1, eighth graders’ 2007 TAKS science achievement. The immersion effect was negative. Additionally, there was a statistically significant interaction between pretest and posttest scores. As students’ TAKS science pretest scores increased, the achievement gap favoring control students over immersion widened for 2007 TAKS science scores. Thus, immersion had a negative effect on the science scores of higher achieving eighth graders.

- **TAKS writing.** After controlling for Cohort 2 seventh graders’ pretest writing scores (fourth grade), demographic characteristics, and campus poverty, there was no statistically significant difference in the TAKS writing scores for immersion and control students. The immersion effect was negative but not by a significant margin.

# 7. Factors Associated with Implementation and Outcomes

In Chapter 3, we reported findings on the implementation of technology immersion for the second and third project years (2005-06 and 2006-07, respectively). Findings revealed some third-year improvements relative to school supports for implementation as well as the extent of teachers' Classroom Immersion. Student Access and Use, in contrast, remained stable across years and generally fell short of expectations. Implementation evidence, on the other hand, showed wide variation across schools and classrooms. For the third year, we estimated that about a quarter of middle schools (5) with complete data sets had a much stronger presence of the immersion components that more nearly approximated expected standards. Given the variation in implementation from school-to-school and from classroom-to-classroom, we report in this chapter on investigations of factors that are associated with the implementation levels of technology immersion, and the relationships between implementation levels and student academic achievement. Implementation is measured as the fidelity with which technology immersion *components* and related *elements* attained the model's envisioned ideal (see implementation indicators in Exhibit 7.1).

**Exhibit 7.1. Implementation Indicators for Technology Immersion**

**Immersion Support Index** is an aggregate score for school-level indicators of support for technology immersion.

- ***Leadership*** is a measure of administrative leadership for technology.
- ***Teacher Support*** is a measure of teachers' commitment to immersion.
- ***Parent and Community Support*** is a measure of support for the school's technology efforts.
- ***Technical Support*** is a measure of the extent to which technical support alleviates problems that create barriers to immersion.
- ***Professional Development*** is an aggregate indicator of the quality of campus professional development as measured by four elements: *Contact Hours, Classroom Support, Content Focus,* and *Coherence.*

**Classroom Immersion Index** is an aggregate score for teacher-level immersion indicators.

- ***Technology Integration*** is a measure of a teacher's ideological orientation towards classroom technology immersion.
- ***Learner-Centered Instruction*** is a measure of a teacher's ideological orientation towards student-centered learning practices.
- ***Student Activities*** is a measure of the frequency of students' use of technology resources in a teacher's classroom.
- ***Communication*** is a measure of a teacher's technology-based communications with students, parents, and peers.
- ***Professional Productivity*** is a measure of a teacher's use of technology for professional activities.

**Student Access and Use Index** is an aggregate score for student-level immersion indicators.

- ***Laptop Access Days*** is a measure of the extent to which a student has access to a laptop throughout the school year.
- ***Core-Content Learning*** is a measure of the frequency that a student reports using technology for learning in core-subject classes.
- ***Home Learning*** is a measure of the extent that a student uses a laptop for core-subject homework (language arts [reading/writing], social studies, science, and math) or to play games to learn outside of school.

**Implementation Index** is an implementation score for each school, which is an aggregate score for the three implementation components described above.

*Note.* Implementation indices are *z* scores with a mean of 0 and standard deviation of 1.0.

For analyses of the factors associated with implementation and outcomes, we used standardized implementation indicators ($z$ scores with a mean of 0 and a standard deviation of 1.0) that could be analyzed individually or aggregated to generate component scores and an overall implementation score. Analyses involved indicators that assessed school supports for immersion (Immersion Support Index), the extent of teachers' classroom immersion (Classroom Immersion Index), and the extent of students' technology access and use (Student Access and Use Index).

## Factors Associated with Model Implementation

In the section below, we explore relationships among various implementation components and examine whether particular support mechanisms or school characteristics are associated with schools' levels of Classroom Immersion and Student Access and Use. The strength of relationships between implementation levels (mean campus $z$ scores) and school characteristics (campus enrollment, percentages of minority and economically disadvantaged students, and percentages of students passing TAKS tests) are examined individually through bivariate correlations.

### Immersion Components

Table 7.1 displays the correlations between seven components of technology immersion, with statistically significant coefficients denoted in bold. As anticipated, teachers' perceptions of their school's administrative leadership was significantly associated with their perceived supports for implementation, including their collective support for technology innovation, views on parent and community support, prevalence of technical support, and robustness of professional development. Reasonably, teachers' support for technology innovation was significantly related to other support mechanisms. The strength of administrative leadership and the intensity of campus professional development supporting immersion were significantly associated with higher levels of Classroom Immersion.

**Table 7.1. Correlations of Technology Immersion Components**

| Component | Components of Technology Immersion | | | | | | |
|---|---|---|---|---|---|---|---|
| | Immersion Support | | | | | Classroom Immersion | Student Access/Use |
| | Leader-ship | Teacher Support | Parent Support | Technical Support | PD | | |
| Leadership | 1.00 | | | | | | |
| Teacher Support | **.81**** | 1.00 | | | | | |
| Parent/Community Support | **.58**** | **.68**** | 1.00 | | | | |
| Technical Support | **.49*** | **.59**** | **.56**** | 1.00 | | | |
| Professional Development | **.64**** | **.59**** | **.50*** | .20 | 1.00 | | |
| Classroom Immersion | **.57**** | .41 | .25 | .14 | **.77**** | 1.00 | |
| Student Access and Use | .28 | **.48*** | .45 | **.54*** | .18 | .18 | 1.00 |

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

*Note*. $N$ = 21 immersion schools. PD = Professional Development.

Teachers' overall support for technology innovation (Teacher Support) was positively associated with the school's level of Student Access and Use. Additionally, students' reported access to and use of laptops was significantly correlated with the quality of technical support for immersion. In general, students had more robust technology experiences when all teachers at a school more strongly supported technology innovation and technical supports addressed maintenance issues that created barriers to student laptop use. School leaders played a key role in providing supports for teachers' classroom immersion efforts.

## School Characteristics

We also explored the relationship between implementation components and school characteristics (see Table 7.2). 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 2007). 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 somewhat 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, indicating that technical problems posed a greater barrier to technology immersion at such schools.

**Table 7.2. Correlations of Technology Immersion Components and School Characteristics**

| | Characteristics of Middle Schools | | | |
|---|---|---|---|---|
| Immersion Component | Student Enrollment | Percent Minority Students | Percent Economically Disadvantaged Students | Percent of Students Passing All TAKS Tests |
| Leadership | -.20 | -.14 | -.38 | .31 |
| Teacher Support | -.24 | -.23 | **-.45*** | .40 |
| Parent & Community Support | -.37 | -.12 | -.33 | **.50*** |
| Technical Support | **-.49*** | -.04 | -.13 | .27 |
| Professional Development | .22 | .11 | -.09 | .00 |
| Classroom Immersion | .18 | -.07 | -.16 | -.12 |
| Student Access & Use | -.31 | -.18 | -.34 | .34 |
| **Implementation Index** | -.16 | -.17 | -.41 | .23 |

*$p < .05$. **$p < .01$.
*Note*. $N = 21$ immersion schools.

Higher percentages of minority students (African American and Hispanic) showed a weakly negative relationship with implementation components. Higher percentages of economically disadvantaged students at a school had an even stronger negative relationship with implementation levels, although only one indicator reached statistical significance. Schools with more disadvantaged populations had significantly lower levels of teacher support for the implementation of innovative technology practices. In contrast to the negative relationships between school demographic characteristics and 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. On the other hand, teachers' perceptions of parent and community support for technology was significantly and positively associated with students' TAKS 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 7.3 showed generally low associations among variables, with some positive and some negative relationships. Still, a few statistically significant findings surfaced. Classroom Immersion elements gauging 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 administrative leadership, parent and community support, and professional development. Teachers' perceptions of the robustness of professional development showed the strongest relationship with the elements of Classroom Immersion and the composite index.

**Table 7.3. Correlations of Support Components and School Characteristics by Elements of Classroom Immersion**

| | Core-Subject Teachers' Classroom Immersion | | | | | |
|---|---|---|---|---|---|---|
| Indicator/Characteristic | Technology Integration | Learner-Centered Instruction | Student Activities | Communi-cation | Professional Productivity | **Classroom Immersion Index** |
| Leadership | **.65**** | **.54*** | **.65**** | .24 | .15 | **.57**** |
| Teacher Support | **.59**** | **.43*** | **.51*** | .10 | -.04 | .41 |
| Parent & Community Support | **.44*** | .36 | .32 | .00 | -.14 | .25 |
| Technical Support | .28 | .21 | .27 | -.07 | -.13 | .14 |
| Professional Development | **.80**** | **.75**** | **.61**** | **.49*** | .35 | **.77**** |
| School enrollment | .07 | .02 | .12 | .29 | .30 | .18 |
| % minority students | -.13 | .05 | -.08 | -.10 | .07 | -.07 |
| % Disadvantaged students | -.16 | .08 | -.14 | -.28 | .03 | -.16 |
| % Students pass all TAKS | .02 | -.13 | -.16 | -.10 | -.23 | -.12 |

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

*Note*. *N* = 21 immersion schools.

Also, as illustrated in Table 7.3, significant associations linked the strength of administrative leadership with greater teacher ideological affiliations, frequency of Student Activities, and the overall level of Classroom Immersion. On the other hand, there were generally weak relationships between the characteristics of schools and the elements of Classroom Immersion. Moreover, the school's mean achievement on TAKS was negatively associated with teachers' implementation levels for almost all of the Classroom Immersion elements.

## Student Access and Use

Correlations for students' reported levels of technology access and use showed important trends (Table 7.4). First, the strength of the composite Student Access and Use Index was significantly related to stronger levels of teacher and technical support for implementation. And, although correlations were statistically insignificant, the index was negatively associated with larger school size and higher percentages of minority and economically disadvantaged students.

**Table 7.4. Correlations for Support Components and School Characteristics by Elements of Student Access and Use**

| | Student Technology Access and Use | | | |
|---|---|---|---|---|
| Indicator/Characteristic | Laptop Access Days | Classroom Learning | Home Learning | **Student Access/Use Index** |
| Leadership | -.33 | .36 | .17 | .28 |
| Teacher Support | -.10 | .42 | .37 | **.48*** |
| Parent & Community Support | .18 | .40 | .26 | .45 |
| Technical Support | .12 | **.50*** | .34 | **.54*** |
| Professional Development | -.27 | .07 | .31 | .18 |
| School Enrollment | -.31 | **-.51*** | .14 | -.31 |
| % Minority Students | -.08 | -.38 | .16 | -.18 |
| % Disadvantaged students | -.06 | -.39 | -.11 | -.34 |
| % Students pass all TAKS | .19 | .27 | .15 | .29 |

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

*Note*. Data are for 19 immersion schools. Two schools did not submit student surveys.

Second, unexpectedly, the perceived strength of campus technical support was not strongly related to the number of days that students had their laptops available for use; however, technical support was significantly associated with the frequency with which students used their laptops for learning in core-subject classrooms. There were no significant associations between teachers' perceived supports for immersion and students' tendencies to use their laptops for learning at home (i.e., homework and learning games). However, the robustness of a student's technology access and use was negatively 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. On the other hand, students' reported technology access and use was positively, though weakly, associated with campus academic achievement.

## Factors Associated with Student Outcomes

An additional investigation of the associations between implementation fidelity and student academic outcomes involved data for individual students and their teachers. We used a series of two-level hierarchical linear models (HLM), in which students were nested within teachers' classrooms, to investigate whether the levels of implementation for two teacher-related implementation components (Immersion Support Index, Classroom Immersion Index) and one student-specific component (Student Access and Use Index) were significant predictors of students' TAKS reading and mathematics scores. We analyzed the effects of implementation on academic achievement for Cohorts 1, 2, and 3 students.

In the student-level model (level 1), 2007 TAKS *T* scores were regressed on 2006 TAKS *T* scores, the Student Access and Use Index (*z* score), economic status (0 if not disadvantaged, 1 if disadvantaged), African American status (0 if not African American, 1 if African American), Hispanic status (0 if not Hispanic, 1 if Hispanic) and gender (0 if male, 1 if female). The teacher-level model (level 2) investigated whether the Immersion Support Index (average campus *z* score) and Classroom Immersion Index (individual teacher *z* score) predicted higher 2007 TAKS scores, after adjusting for school poverty, students' prior achievement and demographic characteristics, and Student Access and Use. We also investigated whether Student Access and Use predicted higher 2007 TAKS scores, after adjusting for initial achievement, student demographic characteristics, school poverty, Immersion Support, and Classroom Immersion. School poverty was a continuous variable indicating the percentage of economically disadvantaged students in a school, with a mean of 69.8%. Analyses for Cohorts 1, 2, and 3 involved approximately 1,200, 1,300, and 1,600 students, respectively, who were enrolled continuously in schools during three, two, and one project years.

### TAKS Reading

Table 7.5 provides estimates of the effects of implementation on Cohorts 1, 2, and 3 students' 2007 TAKS reading *T* scores. We examined the effects of implementation for both students and teachers. First, at the teacher level, we investigated whether the strength of reading teachers' campus support for implementation (Immersion Support) and their reported levels of Classroom Immersion were predictors of students' reading achievement. Results for Immersion Support were mixed. After controlling for student variables (prior achievement, demographic characteristics, Student Access and Use) and other teacher variables (school poverty and Classroom Immersion), Immersion Support was a statistically significant and positive predictor of Cohort 1 eighth graders' reading achievement. That is, controlling for other variables in the analysis, students whose teachers had average levels of Immersion Support ($z$ = -0.11) had higher 2007 TAKS reading scores (1.34 *T* score points) than students with teachers having support that was approximately one standard deviation below average. Conversely, for Cohorts 2 and 3, there was no significant association between Immersion Support and students' reading scores. Moreover, reading teachers' level of Classroom Immersion, surprisingly, was an insignificant predictor of students' TAKS achievement. In fact, for Cohorts 1 and 3, after adjusting for other variables in the analysis, students who had reading teachers with average levels of Classroom Immersion had lower TAKS reading *T* scores (-0.23 and -0.71, respectively) than students with teachers having below average Classroom Immersion scores.

**Table 7.5. Hierarchical Regression Models Predicting the Effects of Implementation Components on TAKS Reading Achievement**

| | Cohort 1<br>Eighth Graders<br>*N* = 1,217 | | Cohort 2<br>Seventh Graders<br>*N* = 1,297 | | Cohort 3<br>Sixth Graders<br>*N* = 1,606 | |
|---|---|---|---|---|---|---|
| Predictor | Gamma Coefficient | *t*-value | Gamma Coefficient | *t*-value | Gamma Coefficient | *t*-value |
| Intercept | 49.803 | 128.06*** | 50.984 | 74.56*** | 48.869 | 103.51*** |
| Teacher-level predictors | | | | | | |
| School poverty | 3.112 | 1.76 | 3.125 | 0.97 | 1.185 | 0.75 |
| **Immersion Support** | 1.340 | 5.62*** | -0.129 | -0.25 | -0.030 | -0.10 |
| **Classroom Immersion** | -0.234 | -0.64 | 0.688 | 1.21 | -0.705 | -2.02† |
| Student-level predictors | | | | | | |
| Spring 2006 *T* score | 0.537 | 23.03*** | 0.654 | 19.77*** | 0.532 | 27.99*** |
| **Student Access and Use** | 0.542 | 2.05* | 0.895 | 2.56* | 0.523 | 1.88† |
| Female | 0.394 | 1.10 | -0.027 | -0.06 | 0.785 | 2.98** |
| African American | -0.285 | -0.31 | -2.562 | -2.91** | -0.837 | -1.21 |
| Hispanic | -0.949 | -2.07* | -2.443 | -2.84** | -0.939 | -1.91† |
| Eco. Disadvantaged | -1.039 | -2.53* | -0.625 | -1.13 | -0.266 | -0.68 |

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

*Note.* Numbers of reading teachers: Cohort 1 = 39, Cohort 2 = 37, and Cohort 3 = 41.

In contrast to results for teachers, the level of Student Access and Use (of technology) had a statistically significant positive relationship with reading achievement. Student-level results for the three cohorts show that after controlling for students' prior reading achievement, demographic characteristics, and teacher-level variables (school poverty and implementation components), Student Access and Use was a significant predictor of students' 2007 TAKS reading *T* scores. For Cohorts 1, 2, and 3, the sizes of the technology access and use effect on TAKS reading achievement were 0.54, 0.90, and 0.52 *T*-score points, respectively. As an example, after controlling for all of the other variables in the analysis, an economically advantaged, non-minority, male eighth grader with a score one standard deviation above average for Student Access and Use ($z = 1.03$), had a 0.54 *T*-score point higher TAKS reading score. Moreover, with each additional standard deviation increase in Student Access and Use, students' reading achievement increased even more.

Additionally, we conceptualized Student Access and Use as having multiple elements (Laptop Access Days, Core-Content Learning, and Home Learning), and thus, were interested in separately predicting variation for each element. Table 7.6 provides statistics for the HLM models used to predict each of the three elements. Findings revealed that Home Learning—which measured the extent of a student's laptop use outside of school for homework in each of the four core-subject areas and for learning games—was the strongest implementation predictor of reading achievement. The Home Learning effect on TAKS reading scores was positive for Cohort 1 (0.31 *T*-score point) and statistically significant and positive for Cohort 2 (1.01 *T*-score point) and Cohort 3 (0.39 *T*-score point). In contrast, the number of days during the school year that students had laptops available for use (Laptop Access Days) was weakly associated with students' reading achievement. The frequency that students reported using their laptops in their four core-subject classes (Core-Content Learning) was a non-significant positive predictor of achievement for Cohort 1 students, a significantly negative predictor for Cohort 2, and a negative predictor for Cohort 3.

**Table 7.6. Hierarchical Regression Models Predicting the Effects of Implementation Components (including Elements of Student Access and Use) on TAKS Reading Achievement**

| | Cohort 1 Eighth Graders | | Cohort 2 Seventh Graders | | Cohort 3 Sixth Graders | |
|---|---|---|---|---|---|---|
| Teacher-Level Analysis | Gamma Coefficient | *t*-value | Gamma Coefficient | *t*-value | Gamma Coefficient | *t*-value |
| Intercept | 49.803 | 130.90*** | 51.196 | 75.77*** | 48.883 | 104.32*** |
| Teacher-level predictors | | | | | | |
| School poverty | 3.287 | 1.65 | 2.916 | 0.93 | 1.026 | 0.65 |
| **Immersion Support** | 1.325 | 5.45*** | 0.143 | 0.32 | -0.030 | -0.10 |
| **Classroom Immersion** | -0.261 | -0.72 | 0.762 | 1.33 | -0.688 | -2.03* |
| Student-level predictors | | | | | | |
| Spring 2006 *T* score | 0.537 | 22.03*** | 0.640 | 18.44*** | 0.531 | 27.80*** |
| **Laptop Access Days** | -0.033 | -0.32 | 0.120 | 0.41 | 0.060 | 0.22 |
| **Core-Content Learning** | 0.246 | 0.81 | -0.485 | -2.00* | -0.050 | -0.30 |
| **Home Learning** | 0.311 | 1.37 | 1.010 | 6.14*** | 0.394 | 3.01** |
| Female | 0.415 | 1.19 | -0.142 | -0.32 | 0.752 | 2.82** |
| African American | -0.284 | -0.31 | -2.423 | -2.84** | -0.785 | -1.16 |
| Hispanic | -0.931 | -1.96* | -2.630 | -3.05** | -0.904 | -1.86$^{\dagger}$ |
| Eco. Disadvantaged | -1.054 | -2.60* | -0.558 | -1.06 | -0.289 | -0.74 |

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

*Note.* Numbers of reading teachers: Cohort 1 = 39, Cohort 2 = 37, and Cohort 3 = 41.

## TAKS Mathematics

We also estimated the effects of implementation on students' 2007 TAKS mathematics *T* scores. Like reading, we examined implementation effects for students and teachers (Table 7.7). Teacher-level findings for Immersion Support varied across student cohorts. After controlling for other variables in the analysis, Immersion Support was a statistically significant and positive predictor of Cohort 1 students' mathematics achievement (comparable to effects for TAKS reading). That is, eighth graders who had mathematics teachers with average levels of Immersion Support ($z$ = -0.02) had higher 2007 TAKS mathematics scores (1.46 *T*-score points, on average) than students who had teachers with Immersion Support that was about one standard deviation below average. For Cohorts 2 and 3, there was no significant association between Immersion Support and students' mathematics achievement.

**Table 7.7. Hierarchical Regression Models Predicting the Effects of Implementation Components and TAKS Mathematics Achievement**

| | Cohort 1 Eighth Graders *N* = 1,171 | | Cohort 2 Seventh Graders *N* = 1,382 | | Cohort 3 Sixth Graders *N* = 1,389 | |
|---|---|---|---|---|---|---|
| Teacher-Level Analysis | Gamma Coefficient | *t*-value | Gamma Coefficient | *t*-value | Gamma Coefficient | *t*-value |
| Intercept | 51.550 | 83.22*** | 48.703 | 85.70*** | 47.917 | 80.95*** |
| Teacher-level predictors | | | | | | |
| School poverty | 8.713 | 2.84** | 4.608 | 1.55 | 5.418 | 1.55 |
| **Immersion Support** | 1.464 | 2.99** | 0.643 | 0.98 | -0.206 | -0.26 |
| **Classroom Immersion** | -0.174 | -0.23 | 0.621 | 1.76$^{\dagger}$ | 0.292 | 0.59 |
| Student-level predictors | | | | | | |
| Spring 2006 *T* score | 0.707 | 28.19*** | 0.731 | 28.15*** | 0.689 | 32.23*** |
| **Student Access and Use** | 0.809 | 3.34** | 0.864 | 3.40** | 0.889 | 2.97** |
| Female | -0.477 | -1.52 | -0.178 | -0.60 | 1.025 | 2.67** |
| African American | -1.037 | -1.63 | -0.553 | -1.11 | -1.219 | -1.34 |
| Hispanic | -0.611 | -0.82 | -1.187 | -2.31* | -0.667 | -0.98 |
| Eco. Disadvantaged | -0.736 | -1.96* | 0.129 | 0.31 | -0.518 | -0.94 |

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

*Note.* Numbers of mathematics teachers: Cohort 1 = 39, Cohort 2 = 40, and Cohort 3 = 33.

After statistical adjustments for the other variables in the analysis, mathematics teachers' reported Classroom Immersion level, similar to reading teachers, had an insignificant relationship with students' TAKS achievement. Teachers' Classroom Immersion was a negative predictor of TAKS math achievement for Cohort 1 and a positive predictor for Cohorts 2 and 3. In contrast to teacher-related implementation indicators, students' reported level of Student Access and Use was a statistically significant positive predictor of 2007 TAKS mathematics $T$ scores for each of the student cohorts. Controlling for students' prior math achievement, demographic characteristics, and teacher-level variables (implementation components as well as school poverty), the sizes of the Student Access and Use effects were 0.81, 0.86, and 0.89 $T$-score points for Cohorts 1, 2, and 3 students, respectively. For example, after controlling for other variables in the analysis, an economically advantaged, non-minority, male eighth grader with a score approximately one standard deviation above average ($z = 1.02$) for Student Access and Use had a 0.81 $T$-score point higher TAKS mathematics score than a student with an average Student Access and Use score ($z = 0.02$). TAKS mathematics achievement increased incrementally as students' reported levels of technology access and use increased.

To gain a greater understanding of the association between students' reported technology access and use and mathematics achievement, we used HLM to predict math achievement for each of the three Student Access and Use elements (Laptop Access Days, Core-Content Learning, and Home Learning). Results in Table 7.8, similar to TAKS reading outcomes, show that the extent to which students reported using their laptops for Home Learning was a statistically significant predictor of TAKS mathematics scores. The Home Learning effect on mathematics achievement was similarly positive for Cohort 1 (0.68 $T$-score point), Cohort 2 (0.51 $T$-score point), and Cohort 3 (0.50 $T$-score point). As an example, after controlling for the other variables, an economically advantaged, non-minority, male eighth grader with a Home Learning score about one standard deviation above average ($z = 1.08$), had a 0.68 $T$-score point higher TAKS mathematics score. As the extent of laptop use for Home Learning increased, mathematics achievement increased incrementally.

**Table 7.8. Hierarchical Regression Models Predicting the Effects of Implementation Components (Including Elements of Student Access and Use) on TAKS Mathematics Achievement**

| | Cohort 1<br>Eighth Graders | | Cohort 2<br>Seventh Graders | | Cohort 3<br>Sixth Graders | |
|---|---|---|---|---|---|---|
| Predictor | Gamma Coefficient | *t*-value | Gamma Coefficient | *t*-value | Gamma Coefficient | *t*-value |
| Intercept | 51.612 | 85.74*** | 48.787 | 85.55*** | 47.912 | 79.65*** |
| Teacher-level predictors | | | | | | |
| School poverty | 8.304 | 2.82** | 4.617 | 1.61 | 5.191 | 1.49 |
| **Immersion Support** | 1.432 | 3.06** | 0.703 | 1.09 | -0.186 | -0.24 |
| **Classroom Immersion** | -0.244 | -0.34 | 0.612 | 1.80$^{\dagger}$ | 0.340 | 0.70 |
| Student-level predictors | | | | | | |
| Spring 2006 $T$ score | 0.699 | 27.99*** | 0.728 | 27.24*** | 0.686 | 31.42*** |
| **Laptop Access Days** | -0.002 | -0.01 | 0.244 | 1.81 | 0.278 | 1.02 |
| **Core-Content Learning** | 0.019 | 0.07 | 0.032 | 0.15 | 0.057 | 0.29 |
| **Home Learning** | 0.675 | 3.52** | 0.508 | 2.54* | 0.504 | 2.68** |
| Female | -0.490 | -1.54 | -0.215 | -0.69 | 0.974 | 2.49* |
| African American | -1.061 | -1.68 | -0.539 | -1.08 | -1.169 | -1.27 |
| Hispanic | -0.562 | -0.78 | -1.249 | -2.42* | -0.647 | -0.94 |
| Eco. Disadvantaged | -0.801 | -2.12* | 0.140 | 0.33 | -0.506 | -0.91 |

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

*Note.* Numbers of mathematics teachers: Cohort 1 = 39, Cohort 2 = 40, and Cohort 3 = 33.

In contrast to Home Learning, students' reported number of Laptop Access Days and the frequency of laptop use for Core-Content Learning in classrooms were typically positive but non-significant predictors of TAKS mathematics achievement across the three student cohorts.

## Conclusions

In this chapter we described factors associated with the implementation of technology immersion and the relationships between the implementation of immersion components and students' academic achievement. Key findings are the following.

- School administrators appeared to advance implementation through their provision of supports for teachers' technology immersion efforts. Teachers' opinions of the strength of administrative leadership for technology were significantly associated with their perceived levels of implementation support (i.e., collective support for technology innovation, parent and community support, the prevalence of technical support, and the robustness of professional development).
- Although associations between school characteristics and implementation indicators were often statistically insignificant, overall trends showed that schools with larger student enrollments tended to have slightly lower implementation levels than schools with fewer students, and schools with higher percentages of economically disadvantaged students tended to have lower implementation levels. Technical support was a significant problem at larger schools, whereas collective teacher support for technology innovation was a significant issue for schools with greater proportions of disadvantaged students. In contrast, the schools' achievement context (percentage of students passing all TAKS tests), was positively associated with nearly all of the implementation indicators.
- Teachers' views on the robustness of campus Professional Development showed the strongest relationships with the elements of Classroom Immersion and the composite index. Surprisingly, teachers' average implementation levels for the Classroom Immersion Index and its elements were negatively associated with the schools' TAKS achievement.
- The school level of Student Access and Use (of technology) was significantly associated with teachers' overall support for technology innovation and the quality of technical support that addressed infrastructure and maintenance issues causing barriers to students' laptop use. Student Access and Use was negatively associated with larger school size and the percentages of minority and economically disadvantaged students.
- Data analyses for individual students and their teachers showed that the campus measure of Immersion Support and reading and mathematics teachers' reported levels of Classroom Immersion were inconsistent predictors of students' TAKS reading and mathematics achievement.
- Conversely, the level of Student Access and Use (of technology) was a statistically significant positive predictor of students' TAKS reading achievement for Cohort 1 (eighth graders), Cohort 2 (seventh graders), and Cohort 3 (sixth graders). Of the three elements of Student Access and Use, students' use of their laptops for Home Learning—a measure of the extent to which a student uses a laptop outside of school for homework in the four core-subject areas and for learning games—was the strongest predictor of TAKS reading achievement.
- Similar to TAKS reading, the level of Student Access and Use was a statistically significant positive predictor of students' TAKS mathematics achievement for each of the three student cohorts. Like reading, students' use of their laptops for Home Learning was the strongest implementation predictor of TAKS mathematics achievement.

# 8. Conclusions and Implications

The third-year evaluation describes schools' progress in creating technology immersed environments and provides cumulative results on the effects of technology immersion on teachers and students (i.e., a laptop computer for every student and teacher, wireless access throughout the campus, curricular and assessment resources, professional development, and ongoing technical and pedagogical support). Additionally in the third year, we assessed longer term effects of immersion on students' academic achievement and explored associations between project implementation and student outcomes. Although this report concentrates on information gathered during the third project year (2006-07), analyses also include data from the first (2004-05) and second (2005-06) years.

Our research design is quasi-experimental, with 42 grades 6 to 8 middle schools drawn from rural, suburban, and urban locations in Texas. Schools are divided equally between the treatment group (21) and control group (21). The middle schools are typically small (402 students, on average); however, enrollments vary widely (from 83 to 1,447 students). While schools are mainly concentrated in small or very small Texas districts (less than 3,000 students), about a third of schools are in very large districts (10,000 or more students).

The study focused on three student cohorts in the third year. Cohort 1 included eighth graders (2,586 treatment, 2,863 control) who completed their third project year, Cohort 2 included seventh graders (2,644 treatment, 2,882 control) who finished their second project year, and Cohort 3 included sixth graders (2,597 treatment, 2,840 control) who concluded their first year. Students in the cohorts were predominantly minority (65%) and economically disadvantaged (67%).

## Study Limitations

The sample selection process and matching procedures used with the quasi-experimental design appear to have produced a sample of schools with good internal validity, in that there are no large, statistically significant treatment-control group differences. Although baseline data confirmed that the comparison groups were reasonably well matched, we have used statistical methods to adjust for differences that could have arisen from sampling variability. A threat to internal validity was introduced in the third year when control schools began to plan for technology immersion and most of the control teachers received laptops, instructional resources, and more intensive professional development. Consequently, the magnitude of the third-year treatment effects may be underestimated, especially for teachers.

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

## Major Third-Year Findings

Outcomes, as described below, represent the effects of technology immersion for schools that generally had less than full implementation levels. Although the quality of schools' implementation improved slightly in the third year, we estimate that just a quarter of middle schools (5) achieved *substantial immersion* levels, while the remaining schools (16) had *minimal* to *partial immersion*. Major findings from the third year are described in the following sections.

### Effects of Technology Immersion on Teachers and Teaching

In the third project year we assessed the effects of immersion on teachers and teaching by examining teachers' rates of growth on mediating variables across four time points (fall 2004 and spring 2005, 2006, and 2007). Analyses involved 1,684 teachers, including 816 in immersion schools and 868 in control schools. Even though control teachers benefited in the third year from initial steps toward implementation of the technology immersion model, we found that being part of a technology immersion school affected teachers in a number of ways.

**Immersion teachers continued to grow in technology proficiency and in their use of technology for professional productivity at significantly faster rates than control teachers.** Although both treatment and control teachers made progress toward meeting the state's Technology Application Standards, immersion teachers grew at a faster pace. Self-assessments of Technology Proficiency across four time points indicated that immersion teachers were 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 teachers in schools with average student poverty, compared to control, were more than twice as steep (0.31 and 0.13 scale-score points per year, respectively, on a 7-point scale). Similarly, teachers in immersion schools grew in their use of technology to enhance their Professional Productivity at a significantly faster rate than control teachers (0.20 and 0.08 scale-score points per year, respectively, on a 5-point scale). Consequently, teachers in immersion schools used technology more frequently for purposes such as communicating with students, posting information on a website, administering online assessments, and accessing model lesson plans.

**Teachers at schools with higher concentrations of student poverty grew in technology proficiency at a slower rate.** Consistent with previous years, teachers who taught at schools with higher levels of student poverty grew in technology proficiency at significantly slower rates than their peers in more advantaged schools. As the level of school poverty increased, the proficiency gap between teachers widened. Weaker supports for implementation at higher poverty immersion schools may at least partially explain teachers' slower progress.

**Teachers at immersion schools expressed increasingly stronger ideological associations across years with technology integration and learner-centered practices.** Initially, immersion and control teachers expressed similar views on instructional practices involving technology, but immersion teachers altered their beliefs about practices at a significantly faster rate. For Technology Integration, the mean estimated growth for immersion teachers in schools with average poverty was 0.59 scale-score point per year compared to 0.24 for control teachers (on a 7-point scale). Thus, immersion teachers increasingly employed actions supporting curricular and instructional infusion of technology, such as promoting students' authentic problem solving or critical thinking through technology. Immersion teachers also expressed increasingly stronger affiliations with constructivist or learner-centered practices, such as having students establish individual learning goals and emphasizing experiential learning. The estimated yearly growth rates in learner-centered practices for immersion and control teachers in average poverty schools were 0.38 and 0.20 scale-score points, respectively, on a 7-point scale.

**Teachers at immersion schools had more collegial interactions on technology-related issues than control teachers, and students used technology more often in immersion classrooms.** Teachers at immersion schools compared to control reported increasingly more frequent collaborative interactions with their colleagues that supported instructional practices involving technology (e.g., developing lesson plans or exchanging information about students). Also, immersion teachers increased the frequency of their students' Classroom Activities involving technology at a more rapid pace than control teachers (for teachers in schools with average poverty, 0.23 scale-score point per year on a 5-point scale versus 0.03 point). Although student activities with technology have steadily increased in immersion classrooms, third-year statistics indicted that students used various technology resources infrequently (i.e., about once or twice a month, $M = 2.65$). Mean statistics, however, obscured the substantial teacher-to-teacher variation in the frequency of students' technology activities both across and within subject areas. Similar to previous years, English language arts, science, and social studies teachers had students use technology considerably more often than mathematics teachers.

**Cumulative evidence suggests that laptop computers and digital resources have allowed students in technology immersion schools to experience slightly more intellectually demanding work.** New resources in technology immersion schools and classrooms are expected to promote students' higher level thinking through more challenging and relevant learning activities that support academic achievement (e.g., Bransford et al., 2003; Newman & Associates, 1996; Newmann, Bryk, & Nagoaka, 2001). Accordingly, researchers have observed lessons in immersion and control teachers' classrooms and rated the Intellectual Challenge of lessons (Newmann et al., 1995). Although observations of core-subject classes (English language arts/reading, mathematics, science, and social studies) in spring of 2005, 2006, and 2007 revealed no statistically significant differences between the overall Intellectual Challenge of immersion and control teachers' instruction, the sizes of effects favoring immersion teachers increased across years. In particular, immersion teachers' lessons had a greater emphasis on Higher Order Thinking over time compared to control teachers. Still, despite positive progress, results for all observed classrooms indicated that lessons in core classes generally failed to intellectually challenge middle-school students, with average ratings mostly below 2 on the 5-point scale.

**As control teachers experienced elements of technology immersion in the third year, the differences favoring treatment teachers for school-level variables began to dissipate.** In contrast to the first two project years, there were no significant differences in the third year between treatment and control teachers' perceptions of either administrative leadership for technology or technical support, and although treatment teachers reported significantly stronger teacher support for technology as well as parent and community support, the effect sizes were much smaller. (See data for comparisons in Appendix F.) Thus, as control teachers experienced components of technology immersion, similar to treatment teachers, they began to view their schools' technology environments as more supportive.

### Effects of Technology Immersion on Students and Learning

In the third project year, we measured student mediating variables across four time periods for Cohort 1 eighth graders (fall 2004 and spring 2005, 2006, and 2007), three periods for Cohort 2 seventh graders (fall 2005 and spring 2006 and 2007), and two periods for Cohort 3 sixth graders (fall 2006 and spring 2007). Analyses for Cohorts 1, 2, and 3, respectively, included 1,337 immersion and 1,467 control students; 1,595 immersion and 1,671 control students; and 1,829 immersion and 2,164 control students. Controlling for important school and student characteristics, key findings include the following.

**Technology immersion significantly increased students' technology proficiency and reduced the proficiency gap between economically advantaged and disadvantaged students.** Across three cohorts, students in technology immersion schools have made greater progress in mastering the Texas Technology Applications standards than control students (e.g., sending an email attachment, creating a presentation, managing documents, using spreadsheets, and keeping track of websites). For Cohort 1, technology immersion had a positive and enduring effect on the technology proficiencies of students from lower socioeconomic backgrounds. By the end of the third year, economically disadvantaged eighth graders in immersion schools were growing in proficiency at a significantly faster yearly rate (0.38 scale-score point on a 5-point scale) than either their more affluent immersion peers (0.31 point) or control-group students (about 0.28 point). For Cohort 2, both economically advantaged and disadvantaged immersion students grew in proficiency at faster rates (0.43 and 0.43 scale-score points, respectively) than their control-group counterparts (0.27 and 0.27 scale-score points). Similarly, for Cohort 3, immersion had a significantly positive effect on sixth graders' technology proficiency (Effect Size [ES] = 0.30).

**Technology immersion significantly increased the frequency of students' classroom technology use and their interactions with peers in small-group activities.** Across three cohorts, students in immersion schools used technology applications significantly more often in their core-subject classrooms than control students. For Cohorts 1 and 2, the yearly growth rates in Classroom Activities for economically advantaged and disadvantaged immersion students ranged from 0.25 to 0.34 scale-score points (on a 5-point scale), compared to 0.04 to 0.10 points for comparable control-group students. Results for Cohort 3 students, similarly, revealed significant and practically important differences in Classroom Activities favoring immersion schools (ES = 0.79). Despite significant increases, third-year statistics (similar to teachers' reports) indicated that students used technology resources infrequently in core classes (about once or twice a month).

Along with greater uses of classroom technology, students in immersion schools also had more frequent opportunities to learn in small groups with their classmates. Cohorts 1 and 2 immersion students had increasing opportunities for small-group work with their peers, whereas control students reported less frequent small-group activities as they advanced to higher grade levels. Cohort 3 students, likewise, had more opportunities for small-group interactions than control students (ES = 0.29). In general, as immersion teachers altered their beliefs about instructional practices, they began to configure student classroom activities differently.

**Students at immersion schools, compared to control, reported mounting technical problems over time when they used computers at school.** Cohorts 1 and 2 immersion students reported increasing technical problems using computers across years compared to control students, with the growth in problems statistically significant for Cohort 1 (eighth graders). Cohort 3 students at immersion schools (sixth graders), who inherited laptops that had been used by students during two previous school years, also reported significantly more technical problems than control group-students. Although increased problems appeared to accompany aging laptops, mean scores in spring 2007 indicated that students, on average, rarely (a few times a year) or just sometimes (once or twice a month) had problems using computers at school.

**Technology immersion and control students regarded themselves as similarly self-directed learners.** Since the independent and self-guided learning afforded through one-to-one technology was expected to positively affect students' personal self-direction, students were asked to complete the *Style of Learning Inventory* as a measure of Self-Directed Learning. Findings in the third year replicated first- and second-year results showing there was no significant immersion effect on students' self-direction. As both immersion and control students in Cohorts 1 and 2 progressed from lower to higher grade levels, their responses to statements measuring self-direction revealed significantly negative growth trends. Thus, students reported less self-regulated learning behaviors across time. Results for Cohort 3, sixth graders, similarly, revealed no significant immersion effect on students' self-direction (ES = 0.11).

**Students in immersion schools had significantly fewer disciplinary actions, similar levels of school satisfaction, and significantly lower school attendance rates than control-group students.** Researchers have associated one-to-one computing with increased student engagement as measured by indicators such as stronger commitment to academic work, reduced discipline problems, and increased school attendance (e.g., MEPRI, 2003; Lowther, Ross, & Morrison, 2003; Rockman ET AL., 1998; 1999; Russell, Bebell, & Higgins, n.d.). Consistent results for the three student cohorts involved in our study show that immersion students exhibited significantly stronger school engagement through more positive behavior. However, they did not express greater satisfaction with school, and they attended school less regularly than control students.

**Behavior and discipline.** Disciplinary Action Reports submitted to the Texas Education Agency (TEA) for each student during the 2006-07 school year, similar to the previous two years, showed that immersion students had proportionately fewer behavioral and disciplinary problems than their counterparts in control schools. Cohorts 1, 2, and 3 immersion students had an average of 0.65, 0.53, and 0.47 disciplinary actions, respectively, compared to 0.90, 0.86, and 0.75 for control students. Although the effect sizes for the mean differences were small, having fewer disciplinary actions per student in middle schools may have important practical benefits in terms of student learning time as well as day-to-day personnel time and effort required for addressing discipline problems that remove students from classrooms.

**School satisfaction.** In the first project year, Cohort 1 students reported significantly higher school satisfaction than control students. However, for the second and third project years, there were no significant differences in school satisfaction between Cohorts 1, 2, and 3 students at immersion and control schools. Across both comparison groups, student cohorts expressed correspondingly modest levels of satisfaction with the kinds of work they do in classes and with the relevance of their schoolwork. First-year school satisfaction ratings reported by Cohort 1 students may have reflected the celebrations and initial excitement that students experienced when laptops were distributed for the first time.

**School attendance.** Contrary to expectations, across three cohorts, students in immersion schools had significantly lower school attendance rates than control-group students. The yearly estimated negative change in attendance for Cohorts 1 and 2 students was greater for immersion students compared to control. Thus, at the end of eighth grade, advantaged students in immersion schools had an average attendance rate of 96.3% compared to 97.2% for control students, and at the end of seventh grade, advantaged students in immersion schools had an average attendance rate of 96.5% compared to 97.3% for control students. Economically disadvantaged immersion students, similarly, had significantly lower attendance rates than their control-group counterparts. Likewise, Cohort 3 immersion students attended school at a significantly lower rate than control students.

The reason *why* immersion students attend school at a lower rate is unclear. It is possible that some students may occasionally skip school so that they can use their laptops at home. Surprisingly, as detailed in the section to follow, immersion students' lower average school attendance was not always associated with lower academic achievement. This contrasts with other research linking lower school attendance rates with lower test scores (e.g., Shapley et al., 2004; Sheehan, 2006).

## Effects of Technology Immersion on Academic Achievement

Increasing middle school students' academic achievement in core subjects as measured by state assessments is the ultimate goal of technology immersion. For analyses reported below, students' Texas Assessment of Knowledge and Skills (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 1,380 immersion and 1,600 control students, Cohort 2 included about 1,550 immersion and 1,725 control students, and Cohort 3 included about 1,780 immersion and 1,990 control students.

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

**Technology immersion had no statistically significant effect on students' TAKS reading achievement.** After controlling for student and school poverty, there were no statistically significant effects of immersion on the TAKS reading growth rates for either Cohort 1 (eighth graders) or Cohort 2 (seventh graders). The immersion effects were positive but not by significant margins. Across cohorts, economically disadvantaged students grew in reading achievement at significantly faster rates than their more affluent peers (0.38 and 0.52 *T*-score points per year for Cohorts 1 and 2 immersion students, respectively; 0.17 and 0.13 *T*-score points for control-group students, respectively). Thus, for economically disadvantaged immersion students, annual growth provided a substantial boost in reading achievement over time. For Cohort 3 sixth graders, after controls for students' prior achievement, demographic characteristics, and school poverty, there was no statistically significant effect of immersion on students' 2007 TAKS reading *T* scores. Similar to the other cohorts, the immersion effect was positive but not by a significant extent (about 0.08 *T*-score point).

**Technology immersion had a statistically significant effect on TAKS mathematics achievement, particularly for economically advantaged and higher achieving students.** After controlling for student and school poverty, technology immersion had a statistically significant effect on students' TAKS mathematics growth rates for Cohorts 1 and 2 students. For Cohort 1, a significant interaction effect revealed that economically advantaged students in immersion schools increased their math achievement at a significantly faster rate than disadvantaged students (about 0.40 *T*-score point per year versus 0.02 *T*-score point, respectively), and at a faster rate than both economically advantaged and disadvantaged control-group students (-0.18 and -0.16 *T*-score points, respectively). For Cohort 2, economically advantaged and disadvantaged immersion students had TAKS mathematics growth rates (0.26 and 0.30 *T*-score points per year, respectively) that significantly outpaced their control-group counterparts (-0.44 and -0.40 *T*-score points).

For Cohort 3 sixth graders, after controlling for students' prior achievement, demographic characteristics, and school poverty, there was a statistically significant effect of immersion that acted through students' pretest scores. Other factors being equal, as students' TAKS pretest scores increased, the achievement gap favoring immersion students over control widened for 2007 TAKS mathematics scores. Thus, immersion had a stronger and significant effect for higher achieving sixth graders.

**Students who had greater access to laptops and used laptops for learning to a greater extent, especially outside of school, had significantly higher TAKS reading and mathematics scores.** Given that the level of implementation of technology immersion varied from school to school, classroom to classroom, and student to student, we used a series of HLM models to investigate the relationships between implementation levels and student academic achievement. Specifically, Student Access and Use was an aggregate implementation measure of the extent to which a student had access to a laptop throughout the school year (number of days), the frequency of technology use for learning in core-subject classes, and the extent of laptop use for homework and learning games. Student-level HLM results showed that the composite measure of Student Access and Use was a statistically significant positive predictor of students' TAKS reading and mathematics achievement for each of the three student cohorts. Of the three elements of Student Access and Use, students' use of their laptops for Home Learning—a measure of the extent to which students used laptops outside of school for homework in the four core-subject areas and for learning games—was the strongest predictor of both TAKS reading and mathematics achievement. In contrast, we found that reading and mathematics teachers' reported levels of Classroom Immersion were typically insignificant predictors of students' academic achievement.

The findings for Student Access and Use, and especially, Home Learning, are important because they reinforce the understanding that student achievement in school depends on individual student initiative as well as what happens outside of school. Results also highlight the important role that individual laptops play in promoting ubiquitous learning and in equalizing the out-of-school learning opportunities for students in disadvantaged family and school situations (Bransford, Brown, & Cocking, 2003; Burbules, 2007; Dede, 2007). Mounting evidence suggests that technology immersion's effect on student achievement is mediated through students' greater ownership of learning allowed through the provision of technology resources that expand where and how learning occurs, that stimulate student attention and self-motivation, and that change the ways students' acquire knowledge and skills (Shapley et al., 2007).

Schools and teachers play a key role in creating conditions that enable students to use their laptops and new technologies to become more capable and dedicated learners. That is, students who attend schools that keep laptops in students' hands and encourage the use of laptops at school and at home for academic pursuits, earn higher test scores. Moreover, students who have at least some teachers who start technology-infused lessons at school that either require or inspire students to continue working at home, or who teach lessons that arouse students' interest in further learning, use their laptops for more academic purposes that promote higher achievement. Additional research is now needed to better understand exactly how laptops and particular technology resources contribute to student thinking, learning, and academic success.

**The effects of technology immersion on reading and mathematics achievement generally became stronger over time as teachers and students became more accomplished technology users.** Across three project years, the immersion effects on reading and mathematics achievement evolved. In the first project year, the immersion effects on TAKS reading and mathematics scores were negative. In the second year, immersion effects were typically positive, but not by statistically significant margins. In the third year, significantly positive immersion effects on TAKS mathematics scores emerged for each of the three student cohorts. Additionally, links were established between higher levels of student implementation and achievement. These finding underscore the importance of longitudinal studies in assessing the impacts of educational initiatives on student achievement. Evidence from this study and others show that a greater number of project implementation years is associated with increasing effects on achievement outcomes (e.g., Borman et al., 2003; Borman, 2005). For technology immersion, higher and more consistent levels of implementation might also produce stronger immersion effects on student achievement.

**Evidence regarding the effects of technology immersion on students' TAKS social studies, science, and writing achievement is inconclusive.** Since TAKS tests for social studies, science, and writing are not administered annually, immersion effects for these subject areas cannot be replicated across cohorts and years. Accordingly, it is not possible to draw definitive conclusions about the effects of technology immersion for these subject areas. Available results typically show no statistically significant effects of immersion, with differences between groups favoring immersion students for TAKS social studies and control students for TAKS science and writing.

**Social studies.** The TAKS social studies test is administered for the first time in 8th grade, so students' 7th grade TAKS reading scores were used to adjust for prior achievement. After controlling for Cohort 1 eighth graders’ reading achievement, demographic characteristics, and school poverty, there was no statistically significant effect of immersion on TAKS social studies scores. The immersion effect was positive (0.57 *T*-score point) but not by a significant degree.

**Science.** After controlling for prior achievement (5th grade science score), demographic characteristics, and school poverty, there was no statistically significant effect of immersion on Cohort 1 eighth graders’ TAKS science achievement. The immersion effect was negative (-0.24 *T*-score point). Also, there was a statistically significant interaction related to students’ pretest scores. As TAKS pretest scores increased, the achievement gap favoring control students over immersion widened for 2007 TAKS science scores. Thus, there was a significantly negative effect on TAKS science scores for higher achieving eighth graders at immersion schools.

**Writing.** After controlling for Cohort 2 seventh graders’ pretest writing scores (4th grade writing score), demographic characteristics, and campus poverty, there was no statistically significant effect of immersion on students’ 2007 TAKS writing scores. The immersion effect was negative (-0.28 *T*-score point). Similarly, there was no statistically significant immersion effect on the 2006 writing scores for Cohort 1 students who completed writing assessments during the second project year. The immersion effect, similar to Cohort 2, was negative (-0.91 *T*-score point). The testing mode for TAKS writing, however, may have influenced student outcomes because the TAKS assessment is administered in paper-and-pencil format. Some research studies show that traditional assessments may underestimate the writing performance of students who are accustomed to using word processors for writing because they are not allowed to use technology when being tested (Russell & Haney, 1997; Russell & Plati, 2001).

## Nature of Third-Year Implementation

In the sections to follow, we describe how the varying levels of project implementation may have contributed to reported outcomes.

**Although the overall level of implementation increased between the second and third project years, just a quarter of schools reached substantial levels of technology immersion.** Full implementation of the technology immersion model requires support in several ways: Leadership, Teacher Support (buy-in), Parent and Community Support, Technical Support, and Professional Development. Given adequate supports, teachers are expected to reach high levels of Classroom Immersion, and Student Access and Use of technology is expected to be robust. Mean immersion standard scores revealed small increases between the second and third implementation years for each of the immersion support components as well as for teachers’ overall level of Classroom Immersion. In contrast, the level of Student Access and Use was stable across years.

Despite progress, evidence from immersion standard scores and the Implementation Index, a composite score measuring the overall presence of immersion components, indicated that just a quarter of middle schools (5) had a stronger presence of the immersion components that more nearly approximated expected implementation standards compared to the other schools (16). Third-year findings, however, showed that technology immersion could have positive effects on teachers and students even at lower implementation stages.

**School administrators advanced implementation through their provision of supports for teachers’ technology immersion efforts, whereas teachers’ greater support for immersion along with technical support elevated Student Access and Use.** Teachers’ opinion of the strength of administrative leadership for technology at their school was significantly associated with their perceived levels of implementation support (i.e., collective support for technology innovation, parent and community support, the prevalence of technical support, and the robustness of professional development).

Additionally, teachers' overall support for technology innovation and the extent to which teachers believed that the quality of technical support addressed infrastructure and maintenance issues causing barriers to students' laptop use, were significantly associated with greater Student Access and Use. To reach higher levels of immersion, many schools needed stronger supports for implementation in the third year.

**Core-subject teachers at the majority of schools reported only partial levels of Classroom Immersion in the third year; teachers at a few schools, however, made collective progress in creating technology-immersed classrooms.** Immersion standard scores for each of five elements of Classroom Immersion showed slightly stronger implementation in the third year, with the largest increases for teachers' ideological affiliations with Technology Integration and Learner-Centered Instruction, and the smallest change for Student Activities with technology in the classroom. There were notable increases in teachers' use of technology as a communication tool and for the enhancement of their own professional productivity. Core teachers (as a whole) at about a fifth of schools reached a substantial level of Classroom Immersion in the third year.

HLM analyses for individual students and their teachers, surprisingly, showed that reading and mathematics teachers' reported levels of Classroom Immersion, in most cases, were statistically insignificant predictors of students' TAKS reading and mathematics achievement. Measurement issues, within classroom variability, and interdisciplinary effects provide potential explanations for findings. First, measures of the elements of Classroom Immersion may not include variables that link directly to student academic achievement. Second, teachers' views reflected their overall perceptions of classroom technology, whereas the nature of classroom immersion varied for individual students due to their inconsistent access to laptops because of lost days for repairs, disciplinary issues, or other reasons. Individual students also utilized their laptops within classes in different ways. Consequently, student-reported activities with technology provided the most salient predictors of academic effects.

Additionally, immersion effects on academic achievement may reflect the efforts of multiple teachers rather than single core-subject teachers. For example, the use of laptops for social studies research and compositions may positively affect reading outcomes. Similarly, exposure to investigations and problem solving activities in science may positively affect mathematics scores. Additional analyses could contribute to a better understanding of the relationship between teachers' use of technology and students' academic outcomes.

**Students' access to and use of laptops for learning within and outside of school generally fell short of substantial to full implementation.** Students at more than two-thirds of schools had just partial levels of Student Access and Use in the third year, whereas students at about a third of schools had only minimal access and use. 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. Year-to-year comparisons indicated that Laptop Access Days declined between the second and third project years. In contrast, students reported small increases in the third year in their use of laptops for Core-Content Learning and Home Learning.

**Larger schools and schools with a greater proportion of economically disadvantaged students had lower levels of implementation.** Overall trends showed that schools with larger student enrollments tended to have slightly lower implementation levels than schools with fewer students, and schools with higher percentages of economically disadvantaged students tended to have lower implementation levels. Technical support was a significant problem at larger schools, whereas collective teacher support for technology innovation was a significant issue for schools with greater proportions of disadvantaged students. Teachers at higher poverty schools also grew in technology proficiency at significantly lower rates, and student access to and use of technology decreased as the percentages of minority and economically disadvantaged students in a school increased. On the contrary, the schools' achievement context (percentage of students passing all TAKS tests), was positively associated with nearly all of the implementation indicators.

These findings are consistent with other studies showing that unequal technology opportunities between higher and lower socioeconomic status schools generally persist despite the infusion of resources that have diminished the digital divide (Education Week, 2007; Warschauer, 2007). Clearly, if students are to realize the full potential of laptops and technology resources, larger schools and schools serving disadvantaged student populations must have adequate supports for technology immersion in place to meet the specific needs of the school's teachers, students, and parents prior to implementing an immersion project.

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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. 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

## Characteristics of Participating Schools

The schools participating in the study are compared in Table B.1. The distribution of middle schools across campus and district enrollment categories shows the comparability of treatment and control groups. For both groups, middle schools are typically small (enrolling 600 students or less), and they are located either in small or very small districts (enrolling 2,999 students or less) or large districts (enrolling 10,000 students or more).

**Table B.1. Campus and District Enrollment by Comparison Group**

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

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

Tables B.2 and B.3 provide campus-level data for each of the 42 schools included in the study. Again, data show that the treatment and control schools are reasonably well matched on baseline characteristics. Middle schools are highly concentrated in rural and very small districts across the state. Still, over a third of districts and schools are in large cities or suburban locations in or around cities. The sample also includes campus charter schools (one each for the treatment and control group) located in a major urban district.

## Table B.2. Characteristics of Technology Immersion and Matched Control Schools

| | Location | | | Students | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Campus | District | District Enroll-ment | Community Type | Grades 6, 7, 8 Number | White (%) | African American (%) | Hispanic (%) | ESL (%) | Special Ed (%) | Eco Disadv (%) | Mobility (%) |
| **Immersion** | | | | | | | | | | | |
| Fruitvale Middle | Fruitvale | 448 | Rural | 100 | 93.0 | 1.0 | 6.0 | 1.0 | 29.0 | 62.0 | 14.6 |
| McLeod Middle | McLeod | 478 | Rural | 138 | 93.5 | 4.3 | 1.4 | 0.0 | 17.4 | 44.2 | 14.6 |
| Monte Alto Middle | Monte Alto | 501 | Rural | 151 | 4.0 | 0.0 | 96.0 | 19.2 | 13.9 | 90.1 | 14.3 |
| De La Paz Middle | Riviera | 511 | Rural | 123 | 35.0 | 0.8 | 63.4 | 6.5 | 17.1 | 62.6 | 12.9 |
| Charlotte Junior High | Charlotte | 514 | Rural | 118 | 16.9 | 0.0 | 83.1 | 1.7 | 17.8 | 66.1 | 12.0 |
| Memphis Middle | Memphis | 530 | Rural | 124 | 46.8 | 12.9 | 40.3 | 12.9 | 19.4 | 65.3 | 14.6 |
| Morton Junior High | Morton | 540 | Rural | 117 | 23.9 | 11.1 | 64.1 | 5.1 | 9.4 | 78.6 | 12.2 |
| Post Middle | Post | 986 | Non-metro: Stable | 207 | 45.4 | 6.8 | 46.9 | 0.0 | 14.5 | 56.5 | 27.1 |
| Floydada Junior High | Floydada | 1,041 | Non-metro: Stable | 240 | 32.5 | 4.2 | 63.3 | 11.3 | 10.8 | 63.3 | 15.1 |
| Newton Middle | Newton | 1,307 | Non-metro: Stable | 299 | 53.8 | 41.8 | 2.0 | 0.3 | 18.1 | 57.9 | 18.8 |
| Dublin Middle | Dublin | 1,331 | Non-metro: Stable | 309 | 53.7 | 0.3 | 45.3 | 5.2 | 12.6 | 64.4 | 17.2 |
| Brady Middle | Brady | 1,385 | Non-metro: Stable | 295 | 54.9 | 3.1 | 41 | 1.4 | 19.3 | 62.0 | 14.5 |
| Franco Middle | Presidio | 1,516 | Non-metro: Stable | 341 | 0.6 | 0.0 | 99.1 | 38.1 | 10.6 | 93.5 | 15.0 |
| Bernarda Junior High | San Diego | 1,542 | Non-metro: Stable | 354 | 1.1 | 0.3 | 98.6 | 11.9 | 13.8 | 82.5 | 11.5 |
| Austin Middle | Bryan | 14,104 | Central city | 962 | 32.7 | 19.4 | 47.1 | 6.1 | 12.4 | 65.0 | 21.7 |
| Woodland Acres Middle | Galena Park | 20,388 | Major suburban | 416 | 7.2 | 7.0 | 85.8 | 22.8 | 11.1 | 85.6 | 12.0 |
| Cigarroa Middle | Laredo | 24,359 | Central city | 1,447 | 0.3 | 0.1 | 99.6 | 57.3 | 18.9 | 99.4 | 17.1 |
| Memorial Middle | Laredo | 24,359 | Central city | 713 | 0.7 | 0.0 | 99.3 | 51.6 | 19.1 | 97.5 | 20.1 |
| Baker Middle | Corpus Christi | 39,185 | Central city | 861 | 21.7 | 2.2 | 71.8 | 0.8 | 9.5 | 49.0 | 17.9 |
| Cullen Middle | Corpus Christi | 39,185 | Central city | 448 | 37.1 | 1.3 | 61.4 | 0.9 | 13.2 | 44.9 | 23.0 |
| Kaleidoscope (Charter) | Houston | 211,157 | Major urban | 110 | 0.9 | 6.4 | 90.9 | 30.0 | 1.8 | 96.4 | 6.1 |
| **Immersion school means** | | | | **375** | **31.2** | **5.9** | **62.2** | **13.5** | **14.7** | **70.8** | **15.8** |

(*Continued*)

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

| | Location | | | Students | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Campus | District | District Enroll-ment | Community Type[a] | Grades 6, 7, 8 Number | White (%) | African American (%) | Hispanic (%) | ESL (%) | Special Ed (%) | Eco Disadv (%) | Mobility (%) |
| **Control** | | | | | | | | | | | |
| Ore City Middle | Ore City | 817 | Non-metro: Stable | 203 | 85.2 | 6.9 | 7.9 | 0.5 | 18.2 | 50.7 | 19.9 |
| Harleton Junior High | Harleton | 624 | Rural | 155 | 97.4 | 2.6 | 0.0 | 0.0 | 12.3 | 25.2 | 15.9 |
| Hamlin Middle | Hamlin | 522 | Rural | 106 | 54.7 | 6.6 | 37.7 | 0.0 | 23.6 | 65.1 | 22.0 |
| O'Donnell Junior High | O'Donnell | 373 | Rural | 83 | 44.6 | 0.0 | 55.4 | 0.0 | 18.1 | 67.5 | 17.3 |
| Odem Junior High | Odem-Edroy | 1,175 | Non-metro: Stable | 287 | 19.5 | 0.0 | 80.1 | 2.8 | 11.5 | 53.3 | 11.3 |
| Wellington Junior High | Wellington | 555 | Rural | 141 | 55.3 | 7.1 | 37.6 | 7.8 | 16.3 | 62.4 | 12.2 |
| Seagraves Junior High | Seagraves | 589 | Rural | 142 | 26.1 | 11.3 | 61.3 | 2.8 | 21.1 | 63.4 | 6.5 |
| Skidmore-Tynan Jr. Hi. | Skidmore-Tynan | 713 | Rural | 176 | 35.8 | 0.6 | 63.6 | 1.7 | 16.5 | 60.2 | 18.8 |
| Slaton Junior High | Slaton | 1,382 | Non-metro: Stable | 335 | 36.1 | 8.7 | 54.9 | 2.1 | 12.5 | 61.5 | 18.6 |
| Timpson Middle | Timpson | 568 | Rural | 140 | 65.7 | 29.3 | 4.3 | 2.1 | 12.1 | 60.7 | 18.6 |
| Cameron Junior High | Cameron | 1,638 | Non-metro: Stable | 372 | 43.5 | 19.9 | 36.3 | 1.3 | 11.8 | 63.2 | 11.0 |
| Coleman Junior High | Coleman | 1,025 | Non-metro: Stable | 248 | 71.8 | 1.6 | 25.8 | 0.0 | 13.3 | 54.0 | 22.3 |
| Truman Middle | Edgewood | 12,873 | Major suburban | 482 | 0.2 | 0.2 | 99.6 | 10.6 | 21.2 | 96.9 | 25.3 |
| Newman Middle | Cotulla | 1,264 | Central city sub. | 281 | 8.5 | 0.0 | 91.5 | 14.2 | 13.5 | 82.9 | 13.9 |
| Rayburn Middle | Bryan | 14,104 | Central city | 1,190 | 51.4 | 27.1 | 20.8 | 2.4 | 11.1 | 47.6 | 16.2 |
| Galena Park Middle | Galena Park | 20,388 | Major suburban | 1,009 | 5.0 | 8.5 | 86.4 | 15.5 | 13.8 | 78.3 | 12.7 |
| Lamar Middle | Laredo | 24,359 | Central city | 1,390 | 1.3 | 0.2 | 98.1 | 26.6 | 17.7 | 90.1 | 14.8 |
| Faulk Middle | Brownsville | 48,857 | Central city | 888 | 0.8 | 0.0 | 99.2 | 37.6 | 19.3 | 99.1 | 18.0 |
| Hamlin Middle | Corpus Christi | 39,185 | Central city | 805 | 25.8 | 3.7 | 69.9 | 1.1 | 17.4 | 56.5 | 19.3 |
| Haas Middle | Corpus Christi | 39,185 | Central city | 476 | 65.4 | 6.5 | 59.5 | 0.6 | 18.9 | 50.6 | 26.4 |
| Briarmeadow (Charter) | Houston | 211,157 | Major urban | 89 | 48.3 | 15.7 | 32.6 | 3.4 | 12.4 | 29.2 | 1.5 |
| **Control school means** | | | | **429** | **40.1** | **7.5** | **53.5** | **6.3** | **15.8** | **62.8** | **16.3** |
| **Immersion school means** | | | | **375** | **31.2** | **5.9** | **62.2** | **13.5** | **14.7** | **70.8** | **15.8** |
| **Overall school means** | | | | **402** | **35.7** | **6.7** | **57.8** | **9.9** | **15.3** | **66.8** | **16.1** |

*Source:* Texas Education Agency AEIS reports 2004.

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

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

# Appendix C

## Survey Items and Scale Reliabilities

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

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

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

| Scale/ Item | Cronbach's Alpha | | | |
|---|---|---|---|---|
| | Fall 2004 | Spring 2005 | Spring 2006 | Spring 2007 |
| **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 | 0.94 | 0.91 |
| Keep administrative records (e.g., attendance). | | | | |
| Manage student assessment data (e.g., electronic gradebooks). | | | | |
| Use technology to analyze and interpret student data to guide instruction. | | | | |
| Create electronic lesson plans. | | | | |
| Communicate with students. | | | | |
| Communicate with parents. | | | | |
| Communicate with colleagues/other professionals. | | | | |
| Create instructional materials (e.g., tests, handouts). | | | | |
| Gather information from the internet to create a lesson (e.g., text, video, clipart). | | | | |
| Access model lesson plans integrating technology. | | | | |
| Deliver information using presentation software (e.g., Powerpoint). | | | | |
| Deliver information using multimedia presentations (text, audio, video, grgraphics). | | | | |
| Post homework, class requirements, or project information on a website. | | | | |
| Administer a formative assessment using Texas Mathematics Diagnostic System. | | | | |

| Scale/<br>Item | Cronbach's Alpha | | | |
|---|---|---|---|---|
| | Fall 2004 | Spring 2005 | Spring 2006 | Spring 2007 |
| Administer other online assessments. | | | | |
| Use the internet at home for instructional purposes. | | | | |
| Use a computer to do schoolwork at home. | | | | |
| **Students' Technology Use:** Students in my class use technology to… | 0.95 | 0.98 | 0.98 | 0.96 |
| 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 | 0.93 | 0.92 |
| Act as a coach or mentor to other teachers or staff at my school. (May include teaching in-service workshop in your school.) | | | | |
| Receive coaching or mentoring from an external (non-school) source such as a professional curriculum developer. | | | | |
| Receive coaching or mentoring from an internal source, such as another teacher or technology coordinator. | | | | |
| Have informal discussions with colleagues regarding strategies for integrating technology. | | | | |
| Receive feedback from other teachers based on their observations of my teaching. | | | | |
| Provide feedback to other teachers based on my observations of their teaching. | | | | |
| Consult with other teachers about certain students' technology skills or use. | | | | |
| Exchange feedback with other teachers based on student work that used technology. | | | | |
| Work with a subject-area peer to develop a lesson plan or class activity using technology. | | | | |
| Work with a colleague in a different subject area to develop a lesson plan. | | | | |
| Participate in a study group with other teachers on a technology-related topic. | | | | |
| **Technology Integration** | 0.94 | 0.95 | 0.95 | 0.91 |
| I alter my instructional use of the classroom computer(s) based upon the newest software applications and research on teaching, learning, and standards-based curriculum. | | | | |
| My students discover innovative ways to use classroom computers to make a difference in their lives. | | | | |
| I allocate time for students to practice their computer skills on the classroom computer(s). | | | | |
| I integrate the most current research on teaching and learning when using the classroom computer(s). | | | | |
| In my classroom, students use technology-based computer and Internet resources beyond the school (NASA, other government agencies, private sector) to solve authentic problems. | | | | |
| My students' authentic problem solving is supported by continuous access to a vast array of computer-based tools and technology. | | | | |
| I plan computer-related activities in my classroom that will improve my students' basic | | | | |

| Scale/<br>Item | Cronbach's Alpha | | | |
|---|---|---|---|---|
| | Fall 2004 | Spring 2005 | Spring 2006 | Spring 2007 |
| skills (e.g., reading, writing, math computation). | | | | |
| It is easy for me to design student-centered, integrated curriculum units that use the classroom computer(s) in a seamless fashion. | | | | |
| I seek out activities that promote increased problem-solving and critical thinking using the classroom computer(s). | | | | |
| Using cutting edge technology and computers, I have stretched the instructional computing in my classroom. | | | | |
| **Learner-Centered Instruction** | 0.75 | 0.80 | 0.81 | 0.81 |
| Students' authentic use of information and inquiry skills guides the type of instructional materials used in my classroom. | | | | |
| My students are involved in establishing individual goals within the classroom curriculum. | | | | |
| In addition to traditional assessments, I consistently provide alternative assessment opportunities that encourage students to "showcase" their content understanding in nontraditional ways. | | | | |
| My instructional approach emphasizes experiential learning, student involvement, and students solving "real-world" issues. | | | | |
| **Resistance to Integration** | 0.70 | 0.72 | 0.77 | 0.81 |
| I do <u>not</u> find computers to be a necessary part of classroom instruction. | | | | |
| Using the classroom computer(s) is <u>not</u> a priority for me this school year. | | | | |
| I do <u>not</u> find the use of computers to be practical for my students. | | | | |

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

| Scale/<br>Item | Cronbach's Alpha | | | |
|---|---|---|---|---|
| | Fall 2004 | Spring 2005 | Spring 2006 | Spring 2007 |
| **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 | 0.91 | 0.92 |
| use a word processor (AppleWorks, Word, etc.) to write a story or report. | | | | |
| use software to learn and practice skills (Riverdeep, Compass Learning, PLATO Learning, etc.). | | | | |
| use a spreadsheet (Excel, etc.) to enter and calculate numbers or create graphs for an assignment. | | | | |
| create a database of information (Filemaker Pro, Access, etc.) for a class project. | | | | |
| create a presentation (PowerPoint, etc.) and present information to classmates or others. | | | | |
| communicate by email with friends, experts, and others about topics you are studying. | | | | |
| use online discussions to gather information for an assignment (discussion boards, videoconferencing, etc.). | | | | |
| conduct Internet research on an assigned topic. | | | | |
| use tools, such as graphing calculators or digital microscopes, to analyze information. | | | | |
| produce print products (with desktop publishing software). | | | | |
| create multimedia reports or projects (with video, graphics, and sound editing). | | | | |
| use technology to complete a test or quiz. | | | | |
| Other | | | | |
| **Technical Problems** | 0.83 | 0.85 | 0.84 | 0.77 |
| The computer is broken or slow. | | | | |
| The program I need is not on the computer. | | | | |
| The Internet connection is too slow or not working. | | | | |
| A website I need is blocked by a filter. | | | | |
| Sharing a computer makes it hard to finish assignments. | | | | |
| My teacher can't fix things when something goes wrong. | | | | |
| Other (describe) | | | | |

| Scale/ Item | Cronbach’s Alpha | | | |
|---|---|---|---|---|
| | Fall 2004 | Spring 2005 | Spring 2006 | Spring 2007 |
| **Small-Group Work:** When students work together in small groups in my classes, we… | 0.80 | 0.83 | 0.83 | 0.83 |
| review and give advice on each other’s work. | | | | |
| tutor or coach each other on difficult work. | | | | |
| make a presentation for the rest of the class. | | | | |
| brainstorm solutions to problems. | | | | |
| discuss previous class assignments. | | | | |
| produce a report or project. | | | | |
| **School Satisfaction** | 0.77 | 0.82 | 0.80 | 0.80 |
| 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 | 0.89 | NA |
| If I'm confused in class, I ask the teacher or another student for help. | | | | |
| Sometimes, if I think an assignment is too tough, I purposely don't try hard. Then if I don't do well, I don't feel bad. | | | | |
| At the end of a project or assignment, I'll think about how hard I worked and whether I would do anything differently next time. | | | | |
| It's important to me that I understand my schoolwork really well. | | | | |
| Even when I think my schoolwork is boring, I keep working until I'm finished. | | | | |
| Before I begin studying, I think about or list the things I'm going to do during my study time. | | | | |
| Even when I'm supposed to learn about something boring, I keep working until I finish. | | | | |
| When my teacher writes comments on assignments, I don't read them unless I have to. | | | | |
| When we start a new unit, I like to know what we're going to be learning and how I'll know if I've learned it well. | | | | |
| When the teacher calls on me, and I make a mistake in class, I can honestly say that I don't feel bad. | | | | |
| When I do well on a big project, it's because I've worked hard. | | | | |
| I work harder than I need to on my schoolwork, because that's just the way I am. | | | | |
| I'll recopy my notes or make diagrams of what we're learning to try and remember it better. | | | | |
| I don't like asking for help with my schoolwork. | | | | |
| If a topic is too hard, it's really hard for me to stay motivated. | | | | |
| If I know I'm going to do badly on a task, I try to avoid it, even if I know I'd learn a lot from it. | | | | |
| There are some subjects I'm just bad at. | | | | |
| A lot of times, I'll wait until the last minute to do my homework or study for a test. | | | | |
| I know I can make a schedule to get my work done on time and stick to it. | | | | |
| When I'm doing homework, I rush to finish if I have ,a friend coming over or if a good TV show is about to start. | | | | |
| I'll look through mistakes I made on earlier assignments so I don't make the same mistakes on new assignments. | | | | |
| When I'm done writing a report, I read it over carefully and think O about whether I've done a good job. | | | | |
| Even if I try, I can't make myself concentrate on schoolwork when there are more interesting things to do. | | | | |
| When I'm reading a chapter, I ask myself questions to make sure I understand the material. | | | | |
| There are some subjects I just can't understand, even if I try hard. | | | | |
| When I get a bad grade, I feel dumb. | | | | |
| I'll pick a tough project where I would learn a lot over an easy project, even if it means I'll have to work harder to get a good grade | | | | |

| Scale/<br>Item | Cronbach's Alpha | | | |
|---|---|---|---|---|
| | Fall 2004 | Spring 2005 | Spring 2006 | Spring 2007 |
| This happens to me a lot: I'll study for a test and think I understand everything; then I take the test and don't do very well. | | | | |
| I don't really take notes when I'm reading something for school. | | | | |
| When I get a grade I don't like, I'll spend time trying to figure out what I could have done differently. | | | | |
| When I do badly on a project, I feel okay as long as I did better than some of the other kids in my class. | | | | |
| When I answer a question wrong in class, I end up wishing I'd never spoken up. | | | | |
| When I get a bad grade, it's because I could have studied more or because I should have done something differently, like taking better notes. | | | | |
| If I'm having trouble concentrating, I find a place to study where I won't be distracted. | | | | |
| The things we're learning in my class are usually really interesting. | | | | |
| If I have to choose, I'd rather get good grades in a class than learn a lot. | | | | |
| When a big project or report is assigned, I make a mental or written schedule to make sure everything gets done on time. | | | | |
| I'll usually ask someone (like my parents, friends or teacher) to give me feedback on my ideas when I'm working on a big assignment. | | | | |
| I know from past experience exactly what I have to do (like schedule a certain amount of time, or take notes in a particular way) if I want to do well on my schoolwork. | | | | |
| If an assignment isn't going to count toward my grade, I don't need to know how well I did on it. | | | | |
| I only feel bad about a low grade if I think I didn't work hard enough, or if I think I made careless mistakes | | | | |
| When I read, I put the important ideas into my own words. | | | | |
| When I'm not feeling motivated, I can't, make myself study. | | | | |
| When I don't understand things in class, I end up thinking it's because I'm not that smart. | | | | |
| When we have a reading assignment, I'll read through it one time, but I don't really go back through it to check how well I remember it. | | | | |
| I know I can do well in school if I try hard enough. | | | | |
| I don't ask for help, even if I don't understand the directions for an assignment. | | | | |
| I wouldn't do any homework if I didn't have to. | | | | |

# Appendix D

## Measurement of Implementation Fidelity

### Defining Technology Immersion

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

#### *Wireless Laptops and Productivity Software*

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

#### *Online Instructional and Assessment Resources*

Immersion packages included a variety of digital resources. Apple included the following online resources: *netTrekker* (an academic Internet search engine), *Beyond Books* from Apex Learning (reading, science, and social studies online), *ClassTools Math* from Apex Learning (complete math instruction), *ExploreLearning Math and Science* (supplemental math/science curriculum), *TeenBiz3000* from Achieve 3000 (differentiated reading instruction), and *My Access Writing* from Vantage Learning (support for writing proficiency). Dell, Inc. selected *netTrekker* (an academic Internet search engine) and *Connected Tech* from Classroom Connect (technology-based lessons and projects). Region 1 ESC selected *Connected Tech* but also added a variety of teaching and learning resources including *Unitedstreaming* (digital videos), *Encyclopedia Britannica*, *EBSCO* (databases), *NewsBank,* and *K12 Teaching and Learning Center*. For the Apple package, *AssessmentMaster* (Renaissance Learning) provides a formative assessment in all four core subject areas. Both the Dell and Region 1 ESC packages provide *i-Know* (CTB McGraw Hill) for core-subject assessment. In addition, all campuses have access to the online Texas Mathematics Diagnostic System (TMDS) and Texas Science Diagnostic System (TMDS) that are provided free of charge by the state.

#### *Professional Development*

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

### *Technical and Pedagogical Support*

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

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

## Measuring Implementation

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

### *Supports for Implementation*

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

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

**Parent and Community Support.** Support from parents and community members is also a key part of implementation because they must understand the goals of technology immersion, assume responsibility along with their children, and assist in enacting effective policies. Our measure of Parent and Community

Support is a scale score composed of teacher survey items (2). These items indicate the extent to which parents support the school's emphasis on technology and the community actively supports instructional efforts with technology. Teachers rated the extent of their agreement on a 5-point scale ranging from 0 (*strongly disagree*) to 4 (*strongly agree*). Substantial to full immersion reflected the strength of teacher agreement. A Parent/Community Support Index was generated by transforming the scale score to a *z* score.

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

**Professional Development.** In constructing measures of professional development, we drew from research conducted on the effectiveness of the Eisenhower Professional Development Program (e.g., Garet, Porter, Desimone, Birman, & Yoon, 2001). Key features of quality professional development provided a framework for examining dimensions of schools' and vendors' professional development models. Data for measures come from core-subject teachers' responses to survey items.

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

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

### *Extent of Implementation*

**Classroom Immersion.** The technology immersion packages included a variety of instructional and assessment resources designed to extend, supplement, or enhance core-subject teaching and learning. Wireless laptops, for example, were loaded with productivity software (i.e., either *Appleworks* or *Microsoft Office*) for students to use as a learning tool. Teachers and students also received a variety of digital resources and formative assessments to support content-area instruction and learning activities.

Indicators for Classroom Immersion, accordingly, assessed the extent to which core-subject teachers at immersion campuses utilized resources and embraced practices consistent with the technology immersion model. Classroom Immersion is measured by five elements: Technology Integration, Learner-Centered Instruction, Student Classroom Activities, Communication, and Professional Productivity. Measures of Technology Integration (10 items) and Learner-Centered Instruction (4 items) are scale scores adapted from the Levels of Technology Implementation (LoTi) Questionnaire. Core teachers indicated the extent to which statements related to Technology Integration (e.g., I alter my instructional practices to support higher order thinking through technology) and Learner-Centered Instruction (e.g., I have students use information and inquiry skills) are true on a 5-point scale, including 0 (*not true of me now),* 1 to 3 (*somewhat true of me now*), and 4 (*very true of me now*).

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

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

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

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

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

### Table D.1. Scoring Rubrics for Measuring the Implementation Fidelity of Technology Immersion—Year 3

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

## Table D.1. Scoring Rubrics for Measuring the Implementation Fidelity of Technology Immersion—Year 3 (*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**<br>Campus Hours<br>1.13 (14 hrs) to 4.0 (70 hrs)<br>M=2.52 (33 hrs)<br>SD=1.06 | Core-subject teachers, on average, participated in 25 or less hours of PD during the past school year. | Core-subject teachers, on average, participated in 26 to 37 hours of PD during the past school year. | Core-subject teachers, on average, participated in 38 to 49 hours of PD during the past school year. | Core-subject teachers, on average, participated in 50 or more hours of PD during the past school year. | -1.80 to 1.79 |
| **Classroom Support**<br>Campus Scores<br>1.37 to 2.93<br>M=2.14<br>SD=0.36 | Core teachers indicate that they *rarely* or *never* receive classroom coaching or mentoring from an internal or external source. | Core teachers indicate that they *rarely* (a few times a year) receive classroom coaching or mentoring from an internal or external source. | Core teachers indicate that they *sometimes* (once or twice a month) receive classroom coaching or mentoring from an internal or external source. | Core teachers indicate that they *often* (once or twice a week) *or almost daily* receive classroom coaching or mentoring from an internal or external source. | |
| **Content Focus**<br>Campus Scores<br>2.00 to 3.73<br>M=2.89<br>SD=0.42 | Core teachers indicate there is *no or almost no PD emphasis* on curriculum, instructional methods, and lesson development in core areas. | Core teachers indicate there is *a minor PD emphasis* on curriculum, instructional methods, and lesson development in core areas. | Core teachers indicate there is a *minor* to *major PD emphasis* on curriculum, instructional methods, and lesson development in core areas. | Core teachers indicate there is a *major PD emphasis* on curriculum, instructional methods, and lesson development in core areas. | |
| **Coherence**<br>Campus Scores<br>1.83 to 3.07<br>M=2.49<br>SD=0.33 | Core teachers indicate that PD is *not at all* consistent with personal and school goals, prior learning, and state standards and assessment. | Core teachers indicate that PD is consistent with personal and school goals, builds on prior learning, and supports state standards and assessment to a *minimal extent*. | Core teachers indicate that PD is consistent with personal and school goals, builds on prior learning, and supports state standards and assessment to a *moderate extent*. | Core teachers indicate that PD is consistent with personal and school goals, builds on prior learning, and supports state standards and assessment to a *great extent*. | |
| **Student Access and Use** | | | | | Campus *z* Scores |
| **Laptop Access Days**<br>Campus Scores<br>1.80 (81 days) to 3.54 (160 days)<br>M=2.50 (115 days)<br>SD=0.51 | Students' laptop access days vary to an *extremely large extent* at a campus, with laptops available from about 80 to 168 days per student. | Students' laptop access days vary to a *large extent* at a campus, with laptops available from about 95 to 175 days per student. | Students' laptop access days vary do a *moderate* extent at a campus, with laptops available from about 140 to 175 days per student. | Students' laptop access days vary to a *small extent* at a campus, with laptops available from about 160 to 180 days per student. | -1.71 to 1.38 |
| **Core-Content Learning**<br>Campus Scores<br>1.42 to 2.98<br>M=2.12<br>SD=0.48 | Students *rarely* (a few times a year) *or never* use technology resources in core-subject classes | Students *sometimes* (once or twice a month) or *often* (once or twice a week) use technology resources in core-subject classes | Students *often* (once or twice a week) or *almost daily* use technology resources in core subjects. | Students use technology resources in core subjects *almost daily*. | |
| **Home Learning**<br>Campus Scores<br>0.40 to 2.58<br>M=1.84<br>SD=0.49 | Students, on average, use their laptops outside of school for homework or learning either *not at all* or to a *trivial extent*. | Students, on average use their laptops outside of school for homework and learning to a *small extent*. | Students, on average, use their laptops outside of school for homework and learning to a *moderate extent*. | Students, on average, use their laptops outside of school for homework and learning to a *large extent.* | |

## Table D.1. Scoring Rubrics for Measuring the Implementation Fidelity of Technology Immersion –Year 3 (*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<br>-2.40 to 1.92 |
| **Technology Integration**<br>Campus Scores<br>1.72 to 3.65<br>M=2.64<br>SD=0.42 | Core teachers indicate it is *not true now* that I alter instructional practices, allocate time, integrate research on teaching and learning, improve basic skills, and support higher order thinking through technology. | Core teachers indicate it is *somewhat true now* that I alter instructional practices, allocate time, integrate research on teaching and learning, improve basic skills, and support higher order thinking through technology. | Core teachers indicate it is *somewhat* or *very true now* that I alter instructional practices, allocate time, integrate research on teaching and learning, improve basic skills, and support higher order thinking through technology. | Core teachers indicate it is *very true now* that I alter instructional practices, allocate time, integrate research on teaching and learning, improve basic skills, and support higher order thinking through technology. | |
| **Learner-Centered Instruction**<br>Campus Scores<br>1.58 to 3.55<br>M=2.62<br>SD=0.45 | Core teachers indicate it is *not true now* that my students establish learning goals, use information and inquiry skills, complete alternative assessments, and have active and relevant experiences. | Core teachers indicate it is *somewhat true now* that my students establish learning goals, use information and inquiry skills, complete alternative assessments, and have active and relevant experiences. | Core teachers indicate it is *somewhat* or *very true now* that my students establish learning goals, use information and inquiry skills, complete alternative assessments, and have active and relevant experiences. | Core teachers indicate it is *very true now* that my students establish learning goals, use information and inquiry skills, complete alternative assessments, and have active and relevant experiences. | |
| **Student Activities**<br>Campus Scores<br>1.79 to 2.97<br>M=2.39<br>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**<br>Campus Scores<br>1.29 to 3.33<br>M=2.50<br>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**<br>Campus Scores<br>2.45 to 3.33<br>M=2.86<br>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<br>-1.55 to 1.89 |

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

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

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

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

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

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

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

| Indicator | Source | Item Description | Index Score | Standards-Based Score |
|---|---|---|---|---|
| **Student Access and Use** | | | | |
| **Laptop Access Days** | Student survey | Q3.a: Does your school provide a laptop that you can use? [Yes = 180 days, No = 0 days]<br>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]<br>Q3.d: How many days was the laptop taken away? [1 to 180] | Continuous variable 0 to 180<br>*z* score | Continuous variable 0 to 180<br>4 = Meet or exceed expectations<br>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?<br>a) Reading/English language arts<br>b) Math<br>c) Science<br>d) Social studies | 5-point scale<br>*z* score | 0 = Never or Rarely (a few times a year)<br>1.333 = Sometimes (once or twice a month)<br>2.667 = Often (once or twice a week)<br>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)]<br>Q4.b: When you take a laptop home, how do you use it?<br>Homework for language arts (reading/writing) [+1]<br>Homework for social studies [+1]<br>Homework for science [+1]<br>Homework for math [+1]<br>Play games to learn [+1] | Continuous variable 0 to 6<br>*z* score | Continuous variable 0 to 6<br>0 = No access to laptop outside school<br>1 = Restricted or full access to laptop outside school<br>+ Laptop used for homework and/or learning outside of school (up to 5 points)<br>4 = Meet or exceed expectations<br>0-3.99 = proportional fraction of requirement |
| **Implementation Index** | | | Composite *z* score | |

# Appendix E

## Technical Appendix—Hierarchical Linear Modeling (HLM)

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

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

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

| Variable Name | *N* | *Mean* | *SD* |
|---|---|---|---|
| **Repeated Measures Descriptive Statistics (Level 1)** | | | |
| Survey Time | 6,736 | 1.50 | 1.12 |
| Technology Proficiency | 4,395 | 4.87 | 1.41 |
| Professional Productivity | 4,357 | 3.23 | 0.72 |
| Technology Integration | 4,146 | 3.66 | 1.56 |
| Learner-Centered Instruction | 4,289 | 4.10 | 1.37 |
| Resistance to Integration | 4,316 | 2.32 | 1.35 |
| Student Classroom Activities | 4,326 | 2.14 | 0.80 |
| Collaboration | 4,356 | 2.51 | 0.77 |
| **School-Level Descriptive Statistics (Level 3)** | | | |
| Immersion status (1 = yes, 0 = no) | 42 | 0.50 | 0.51 |
| School percent economically disadvantaged | 42 | 69.83 | 17.05 |

**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) | 4.673 | 0.086 | 54.61*** |
| | Immersion dummy | -0.184 | 0.121 | -1.52 |
| | School poverty | -0.001 | 0.333 | -0.40 |
| | Growth rate | 0.134 | 0.021 | 6.35*** |
| | Immersion dummy | 0.176 | 0.031 | 5.72*** |
| | School poverty | -0.002 | 0.096 | -2.44* |
| **Professional Productivity** | | | | |
| | Initial status (fall 2004) | 3.023 | 0.061 | 49.94*** |
| | Immersion dummy | -0.094 | 0.083 | -1.14 |
| | School poverty | 0.000 | 0.226 | 0.12 |
| | Growth rate | 0.084 | 0.010 | 8.16*** |
| | Immersion dummy | 0.117 | 0.019 | 6.17*** |
| | School poverty | -0.001 | 0.064 | -0.88 |

*Continued*

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

| | | | | |
|---|---|---|---|---|
| **Technology Integration** | | | | |
| | Initial status (fall 2004) | 2.885 | 0.069 | 41.52*** |
| | Immersion dummy[a] | 0.298 | 0.103 | 2.89** |
| | School poverty | 0.008 | 0.288 | 2.72* |
| | Growth rate | 0.237 | 0.033 | 7.14*** |
| | Immersion dummy[a] | 0.348 | 0.050 | 6.96*** |
| | School poverty | -0.003 | 0.168 | -1.76† |
| **Learner-Centered Instruction** | | | | |
| | Initial status (fall 2004) | 3.670 | 0.060 | 60.79*** |
| | Immersion dummy | -0.028 | 0.088 | -0.32 |
| | School poverty | 0.006 | 0.225 | 2.55* |
| | Growth rate | 0.198 | 0.025 | 7.79*** |
| | Immersion dummy | 0.186 | 0.041 | 4.54*** |
| | School poverty | -0.002 | 0.132 | -1.40 |
| **Resistance to Integration** | | | | |
| | Initial status (fall 2004) | 2.434 | 0.048 | 50.38*** |
| | Immersion dummy[b] | -0.281 | 0.065 | -4.34*** |
| | School poverty | -0.003 | 0.159 | -1.72† |
| | Growth rate | 0.032 | 0.018 | 1.85† |
| | Immersion dummy[b] | -0.017 | 0.030 | -0.58 |
| | School poverty | 0.001 | 0.080 | 1.12 |
| **Student Classroom Activities** | | | | |
| | Initial status (fall 2004) | 1.888 | 0.047 | 40.47**** |
| | Immersion dummy | 0.075 | 0.064 | 1.17 |
| | School poverty | 0.004 | 0.167 | 2.23* |
| | Growth rate | 0.034 | 0.015 | 2.36* |
| | Immersion dummy | 0.199 | 0.027 | 7.43**** |
| | School poverty | -0.001 | 0.083 | -0.91 |
| **Collaboration** | | | | |
| | Initial status (fall 2004) | 2.300 | 0.051 | 44.77*** |
| | Immersion dummy | 0.107 | 0.072 | 1.49 |
| | School poverty | 0.003 | 0.171 | 1.74† |
| | Growth rate | 0.035 | 0.018 | 1.92† |
| | Immersion dummy | 0.065 | 0.029 | 2.20* |
| | School poverty | 0.000 | 0.080 | 0.06 |

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

[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 = -.46).

[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 = -0.26).

**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 | 0.3274 | | | |
| Level-2 individual initial status | 1.7892 | 1,227 | 8,518.80 | 0.000 |
| Level-2 individual growth rate | 0.0319 | 1,227 | 1,783.03 | 0.000 |
| Level-2 school initial status | 0.0729 | 39 | 100.89 | 0.000 |
| Level-2 school growth rate | 0.0041 | 39 | 83.60 | 0.000 |
| **Professional Productivity** | | | | |
| Level-1 temporal variation | 0.1498 | | | |
| Level-2 individual initial status | 0.3225 | 1,221 | 4,134.76 | 0.000 |
| Level-2 individual growth rate | 0.0103 | 1,221 | 1,579.99 | 0.000 |
| Level-2 school initial status | 0.0518 | 39 | 172.93 | 0.000 |
| Level-2 school growth rate | 0.0012 | 39 | 73.55 | 0.001 |
| **Technology Integration** | | | | |
| Level-1 temporal variation | 0.6988 | | | |
| Level-2 individual initial status | 1.2833 | 1,175 | 3,500.47 | 0.000 |
| Level-2 individual growth rate | 0.0332 | 1,175 | 1,481.65 | 0.000 |
| Level-2 school initial status | 0.0430 | 39 | 77.82 | 0.000 |
| Level-2 school growth rate | 0.0144 | 39 | 113.32 | 0.000 |
| **Learner-Centered Instruction** | | | | |
| Level-1 temporal variation | 0.7106 | | | |
| Level-2 individual initial status | 1.0114 | 1,210 | 3,142.50 | 0.000 |
| Level-2 individual growth rate | 0.0274 | 1,210 | 1,444.65 | 0.000 |
| Level-2 school initial status | 0.0240 | 39 | 74.97 | 0.001 |
| Level-2 school growth rate | 0.0065 | 39 | 81.01 | 0.000 |
| **Resistance to Integration** | | | | |
| Level-1 temporal variation | 0.8171 | | | |
| Level-2 individual initial status | 0.7750 | 1,208 | 2,553.34 | 0.000 |
| Level-2 individual growth rate | 0.0695 | 1,208 | 1,594.95 | 0.000 |
| Level-2 school initial status | 0.0037 | 39 | 46.54 | 0.190 |
| Level-2 school growth rate | 0.0009 | 39 | 49.42 | 0.122 |
| **Student Classroom Activities** | | | | |
| Level-1 temporal variation | 0.2123 | | | |
| Level-2 individual initial status | 0.2959 | 1,213 | 3,038.48 | 0.000 |
| Level-2 individual growth rate | 0.0057 | 1,213 | 1,470.93 | 0.000 |
| Level-2 school initial status | 0.0244 | 39 | 109.62 | 0.000 |
| Level-2 school growth rate | 0.0039 | 39 | 111.86 | 0.000 |
| **Collaboration** | | | | |
| Level-1 temporal variation | 0.2479 | | | |
| Level-2 individual initial status | 0.2709 | 1,219 | 2,670.10 | 0.000 |
| Level-2 individual growth rate | 0.0108 | 1,219 | 1,499.93 | 0.000 |
| Level-2 school initial status | 0.0338 | 39 | 126.55 | 0.000 |
| Level-2 school growth rate | 0.0048 | 39 | 110.16 | 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 | 6,736 | 1.50 | 1.12 |
| Technology Proficiency | 4,395 | 4.87 | 1.41 |
| Professional Productivity | 4,357 | 3.23 | 0.72 |
| Technology Integration | 4,146 | 3.66 | 1.56 |
| Learner-Centered Instruction | 4,289 | 4.10 | 1.37 |
| Resistance to Integration | 4,316 | 2.32 | 1.35 |
| Student Classroom Activities | 4,326 | 2.14 | 0.80 |
| Collaboration | 4,356 | 2.51 | 0.77 |
| **Teacher-Level Descriptive Statistics (Level 2)** | | | |
| Male | 1,684 | 0.33 | 0.47 |
| Hispanic | 1,684 | 0.35 | 0.48 |
| African American | 1,684 | 0.05 | 0.21 |
| Experience | 1,684 | 12.28 | 9.62 |
| **School-Level Descriptive Statistics (Level 3)** | | | |
| Immersion status (1 = yes, 0 = no) | 42 | 0.50 | 0.51 |

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

| School-Level Scale | School-Level Analysis | Gamma Coefficient | Standard Error | *t* |
|---|---|---|---|---|
| **Technology Proficiency** | | | | |
| | Initial status (fall 2004) | 4.805 | 0.083 | 57.69*** |
| | Immersion dummy[a] | -0.201 | 0.095 | -2.11* |
| | Male | -0.076 | 0.091 | -0.84 |
| | Hispanic | -0.183 | 0.089 | -2.05* |
| | African American | -0.016 | 0.124 | -0.13 |
| | Experience | -0.053 | 0.004 | -11.71*** |
| | Growth rate | 0.131 | 0.022 | 6.03*** |
| | Immersion dummy[a] | 0.171 | 0.032 | 5.31*** |
| | Male | -0.039 | 0.027 | -1.44 |
| | Hispanic | 0.005 | 0.036 | 0.13 |
| | African American | 0.006 | 0.038 | 0.16 |
| | Experience | 0.003 | 0.001 | 3.21** |

(*Continued*)

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

| | | | | |
|---|---|---|---|---|
| **Professional Productivity** | | | | |
| | Initial status (fall 2004) | 3.102 | 0.060 | 51.59*** |
| | Immersion dummy | -0.095 | 0.077 | -1.23 |
| | Male | -0.193 | 0.056 | -3.42** |
| | Hispanic | 0.019 | 0.042 | 0.45 |
| | African American | 0.090 | 0.072 | 1.25 |
| | Experience | -0.015 | 0.003 | -5.02*** |
| | Growth rate | 0.073 | 0.013 | 5.59*** |
| | Immersion dummy | 0.116 | 0.019 | 6.26*** |
| | Male | 0.003 | 0.018 | 0.15 |
| | Hispanic | 0.005 | 0.014 | 0.34 |
| | African American | 0.030 | 0.030 | 0.97 |
| | Experience | 0.002 | 0.001 | 1.88†*p* |
| **Technology Integration** | | | | |
| | Initial status (fall 2004) | 2.869 | 0.073 | 39.44*** |
| | Immersion dummy[b] | 0.307 | 0.102 | 3.03** |
| | Male | -0.188 | 0.075 | -2.51* |
| | Hispanic | 0.304 | 0.099 | 3.09** |
| | African American | 0.562 | 0.141 | 3.99*** |
| | Experience | -0.016 | 0.004 | -3.69*** |
| | Growth rate | 0.256 | 0.036 | 7.11*** |
| | Immersion dummy[b] | 0.345 | 0.051 | 6.78*** |
| | Male | -0.020 | 0.031 | -0.64 |
| | Hispanic | -0.092 | 0.039 | -2.38* |
| | African American | 0.048 | 0.075 | 0.64 |
| | Experience | 0.002 | 0.001 | 2.04* |
| **Learner-Centered Instruction** | | | | |
| | Initial status (fall 2004) | 3.701 | 0.064 | 58.13*** |
| | Immersion dummy | -0.021 | 0.082 | -0.26 |
| | Male | -0.229 | 0.068 | -3.36** |
| | Hispanic | 0.227 | 0.092 | 2.47** |
| | African American | 0.532 | 0.110 | 4.82*** |
| | Experience | -0.025 | 0.004 | -6.34*** |
| | Growth rate | 0.196 | 0.028 | 7.04*** |
| | Immersion dummy | 0.184 | 0.040 | 4.57*** |
| | Male | -0.011 | 0.036 | -0.30 |
| | Hispanic | -0.034 | 0.038 | -0.90 |
| | African American | 0.025 | 0.069 | 0.36 |
| | Experience | 0.004 | 0.002 | 2.14* |

(*Continued*)

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

| | | | | |
|---|---|---|---|---|
| **Resistance to Integration** | | | | |
| | Initial status (fall 2004) | 2.395 | 0.061 | 39.25*** |
| | Immersion dummy[c] | -0.296 | 0.058 | -5.11*** |
| | Male | 0.423 | 0.077 | 5.48*** |
| | Hispanic | -0.303 | 0.066 | -4.56*** |
| | African American | -0.451 | 0.084 | -5.38*** |
| | Experience | 0.012 | 0.004 | 3.05** |
| | Growth rate | 0.010 | 0.024 | 0.41 |
| | Immersion dummy[c] | -0.015 | 0.031 | -0.47 |
| | Male | 0.024 | 0.039 | 0.62 |
| | Hispanic | 0.058 | 0.031 | 1.88† |
| | African American | 0.075 | 0.060 | 1.24 |
| | Experience | -0.003 | 0.002 | -1.37 |
| **Student Classroom Activities** | | | | |
| | Initial status (fall 2004) | 1.837 | 0.047 | 39.25*** |
| | Immersion dummy | 0.083 | 0.058 | 1.44 |
| | Male | -0.040 | 0.062 | -0.65 |
| | Hispanic | 0.201 | 0.046 | 4.38*** |
| | African American | 0.376 | 0.089 | 4.24*** |
| | Experience | -0.005 | 0.002 | -2.37* |
| | Growth rate | 0.036 | 0.016 | 2.32* |
| | Immersion dummy | 0.196 | 0.026 | 7.53*** |
| | Male | 0.012 | 0.025 | 0.49 |
| | Hispanic | -0.021 | 0.018 | -1.15 |
| | African American | -0.031 | 0.050 | -0.61 |
| | Experience | 0.000 | 0.001 | 0.08 |
| **Collaboration** | | | | |
| | Initial status (fall 2004) | 2.273 | 0.048 | 47.42*** |
| | Immersion dummy | 0.113 | 0.065 | 1.74† |
| | Male | -0.021 | 0.049 | -0.43 |
| | Hispanic | 0.135 | 0.048 | 2.82** |
| | African American | 0.354 | 0.086 | 4.13*** |
| | Experience | -0.007 | 0.002 | -3.63** |
| | Growth rate | 0.030 | 0.020 | 1.54 |
| | Immersion dummy | 0.065 | 0.028 | 2.30* |
| | Male | 0.004 | 0.016 | 0.28 |
| | Hispanic | 0.000 | 0.023 | -0.02 |
| | African American | -0.050 | 0.050 | -1.00 |
| | Experience | 0.001 | 0.001 | 1.28 |

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

[a] Immersed teachers had significantly lower initial technology proficiency 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 = 1.05).

[b] Immersed teachers had significantly lower 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 = -0.77).

[c] Immersed teachers had significantly higher initial levels of 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 = -0.22).

### 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 | 0.3274 | | | |
| Level-2 individual initial status | 1.5672 | 1,223 | 7,562.31 | 0.000 |
| Level-2 individual growth rate | 0.0308 | 1,223 | 1,760.63 | 0.000 |
| Level-2 school initial status | 0.0314 | 40 | 74.24 | 0.001 |
| Level-2 school growth rate | 0.0049 | 40 | 95.01 | 0.000 |
| **Professional Productivity** | | | | |
| Level-1 temporal variation | 0.1502 | | | |
| Level-2 individual initial status | 0.2955 | 1,217 | 3,813.60 | 0.000 |
| Level-2 individual growth rate | 0.0097 | 1,217 | 1,602.71 | 0.000 |
| Level-2 school initial status | 0.0440 | 40 | 157.90 | 0.000 |
| Level-2 school growth rate | 0.0013 | 40 | 74.89 | 0.001 |
| **Technology Integration** | | | | |
| Level-1 temporal variation | 0.6960 | | | |
| Level-2 individual initial status | 1.2380 | 1,171 | 3,394.33 | 0.000 |
| Level-2 individual growth rate | 0.0341 | 1,171 | 1,481.38 | 0.000 |
| Level-2 school initial status | 0.0369 | 40 | 71.07 | 0.002 |
| Level-2 school growth rate | 0.0154 | 40 | 113.22 | 0.000 |
| **Learner-Centered Instruction** | | | | |
| Level-1 temporal variation | 0.7095 | | | |
| Level-2 individual initial status | 0.9432 | 1,206 | 3,014.05 | 0.000 |
| Level-2 individual growth rate | 0.0266 | 1,206 | 1,436.20 | 0.000 |
| Level-2 school initial status | 0.0136 | 40 | 64.10 | 0.009 |
| Level-2 school growth rate | 0.0071 | 40 | 81.83 | 0.000 |
| **Resistance to Integration** | | | | |
| Level-1 temporal variation | 0.8185 | | | |
| Level-2 individual initial status | 0.6967 | 1,204 | 2,403.16 | 0.000 |
| Level-2 individual growth rate | 0.0684 | 1,204 | 1,585.94 | 0.000 |
| Level-2 school initial status | 0.0027 | 40 | 42.56 | 0.361 |
| Level-2 school growth rate | 0.0011 | 40 | 49.54 | 0.143 |
| **Student Classroom Activities** | | | | |
| Level-1 temporal variation | 0.2128 | | | |
| Level-2 individual initial status | 0.2867 | 1,209 | 2,969.13 | 0.000 |
| Level-2 individual growth rate | 0.0055 | 1,209 | 1,470.60 | 0.000 |
| Level-2 school initial status | 0.0161 | 40 | 91.50 | 0.000 |
| Level-2 school growth rate | 0.0039 | 40 | 113.24 | 0.000 |
| **Collaboration** | | | | |
| Level-1 temporal variation | 0.2484 | | | |
| Level-2 individual initial status | 0.2622 | 1,215 | 2,614.80 | 0.000 |
| Level-2 individual growth rate | 0.0106 | 1,215 | 1,499.42 | 0.000 |
| Level-2 school initial status | 0.0242 | 40 | 108.11 | 0.000 |
| Level-2 school growth rate | 0.0046 | 40 | 107.76 | 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, 2, and 3 using two- and three-level HLM models.

### *Effects on Mediating Variables*

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

These multiply-imputed datasets were then analyzed using HLM 6.04. (Note that HLM results from 10 imputed datasets were compared to the results from 5 imputed datasets, and there were essentially no differences in the coefficients. The reduced number of imputed datasets made the HLM analyses mechanically easier to run.) Specifically, researchers used three-level HLM growth models, with controls for school poverty (percentage of economically disadvantaged students) and student poverty (qualification for free- or reduced-price lunch). The models' simplicity aids in the interpretation of effects. Statistical details are provided in Tables E.7, E.8, and E.9 for analyses of mediating variables for Cohort 1. We also 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*[a] | *SD* |
|---|---|---|---|
| **Repeated Measure Descriptive Statistics (Level 1)** | | | |
| Time | 11,705 | 1.50 | 1.12 |
| Time (SLI) | 10,880 | 1.50 | 1.12 |
| Technology Proficiency score | 11,124 | 3.27 | 0.89 |
| Technology Use in School score | 10,552 | 2.32 | 0.81 |
| Technical Problems score | 10,795 | 2.50 | 0.92 |
| Small-Group Work score | 10,643 | 2.79 to 2.80 | 0.86 |
| School Satisfaction score | 10,752 | 3.68 | 0.75 |
| Self-Directed Learning score | 10,396 | 4.45 | 0.74 |
| **Student-Level Descriptive Statistics (Level 2)** | | | |
| Eco. disadvantaged (1 = yes, 0 = no) | 2,942 | 0.72 | 0.45 |
| Eco. disadvantaged (SLI) | 2,720 | 0.72 | 0.45 |
| **School-Level Descriptive Statistics (Level 3)** | | | |
| Immersion status (1 = yes, 0 = no) | 42 | 0.50 | 0.51 |
| School poverty (proportion) | 42 | 0.70 | 0.17 |

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

### 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) | 2.978 | 0.060 | 49.45*** |
| | Immersion dummy | 0.043 | 0.077 | 0.56 |
| | School poverty | -0.126 | 0.231 | -0.54 |
| | Disadvantaged | -0.341 | 0.039 | -8.75*** |
| | Growth rate | 0.267 | 0.015 | 18.19*** |
| | Immersion dummy | 0.043 | 0.028 | 1.53 |
| | School poverty | 0.005 | 0.083 | 0.06 |
| | Disadvantaged | 0.008 | 0.013 | 0.64 |
| | Disadv. x Immersion | 0.058 | 0.014 | 4.22*** |
| **Self-Directed Learning** | | | | |
| | Initial status (fall 2004) | 4.552 | 0.051 | 89.97*** |
| | Immersion dummy[a] | 0.106 | 0.050 | 2.12* |
| | School poverty | 0.339 | 0.153 | 2.22* |
| | Disadvantaged | -0.051 | 0.046 | -1.11 |
| | Growth rate | -0.049 | 0.014 | -3.60** |
| | Immersion dummy[a] | -0.017 | 0.017 | -1.01 |
| | School poverty | -0.023 | 0.042 | -0.55 |
| | Disadvantaged | -0.023 | 0.014 | -1.68 |
| **School Satisfaction** | | | | |
| | Initial status (fall 2004) | 3.740 | 0.030 | 123.30*** |
| | Immersion dummy | 0.064 | 0.038 | 1.68 |
| | School poverty | -0.131 | 0.121 | -1.08 |
| | Disadvantaged | -0.092 | 0.033 | -2.79** |
| | Growth rate | -0.055 | 0.010 | -5.44*** |
| | Immersion dummy | -0.008 | 0.015 | -0.52 |
| | School poverty | 0.163 | 0.038 | 4.33*** |
| | Disadvantaged | 0.034 | 0.012 | 2.75** |
| **Classroom Activities** (with technology) | | | | |
| | Initial status (fall 2004) | 2.020 | 0.069 | 29.37*** |
| | Immersion dummy[b] | 0.257 | 0.079 | 3.26** |
| | School poverty | -0.298 | 0.223 | -1.34 |
| | Disadvantaged | 0.013 | 0.030 | 0.43 |
| | Growth rate | 0.040 | 0.025 | 1.63 |
| | Immersion dummy[b] | 0.212 | 0.033 | 6.34*** |
| | School poverty | 0.082 | 0.096 | 0.86 |
| | Disadvantaged | 0.044 | 0.014 | 3.08** |
| **Small-Group Work** | | | | |
| | Initial status (fall 2004) | 2.802 | 0.058 | 48.73*** |
| | Immersion dummy | 0.058 | 0.058 | 0.99 |
| | School poverty | -0.154 | 0.194 | -0.80 |
| | Disadvantaged | -0.051 | 0.053 | -0.96 |
| | Growth rate | -0.055 | 0.021 | -2.56* |
| | Immersion dummy | 0.072 | 0.026 | 2.79** |
| | School poverty | -0.052 | 0.089 | -0.59 |
| | Disadvantaged | 0.056 | 0.020 | 2.79** |

(*Continued*)

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

| | | | | |
|---|---|---|---|---|
| **Technical Problems** | | | | |
| | Initial status (fall 2004) | 2.366 | 0.063 | 37.39*** |
| | Immersion dummy | -0.138 | 0.071 | -1.95 |
| | School poverty | -0.324 | 0.249 | -1.30 |
| | Disadvantaged | -0.071 | 0.069 | -1.04 |
| | Growth rate | 0.101 | 0.031 | 3.27** |
| | Immersion dummy | 0.095 | 0.039 | 2.43* |
| | School poverty | 0.073 | 0.137 | 0.53 |
| | Disadvantaged | 0.024 | 0.026 | 0.93 |

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

[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 = 0.88).

[b] Immersion students had significantly higher initial classroom activities scores. A latent variable regression, controlling for the effect of this initial difference on the growth rate, indicated that the difference between the original (0.138) and adjusted (0.212) immersion coefficients was significant (the difference divided by the standard error of the difference = -2.63). The growth rate coefficient adjusted for this difference is reported in the table.

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

| Test/ Random Effect | Variance Component | *df* | $X^2$ | *p* |
|---|---|---|---|---|
| **Technology Proficiency** | | | | |
| Level-1 temporal variation | 0.2838 | | | |
| Level-2 individual initial status | 0.4292 | 2877 | 8778.23 | 0.000 |
| Level-2 individual growth rate | 0.0287 | 2877 | 4286.32 | 0.000 |
| Level-3 school initial status | 0.0519 | 39 | 276.47 | 0.000 |
| Level-3 school growth rate | 0.0061 | 39 | 265.29 | 0.000 |
| **Self-Directed Learning** | | | | |
| Level-1 temporal variation | 0.2149 | | | |
| Level-2 individual initial status | 0.3627 | 2677 | 8820.93 | 0.000 |
| Level-2 individual growth rate | 0.0202 | 2677 | 3891.69 | 0.000 |
| Level-3 school initial status | 0.0136 | 39 | 113.37 | 0.000 |
| Level-3 school growth rate | 0.0015 | 39 | 96.58 | 0.000 |
| **School Satisfaction** | | | | |
| Level-1 temporal variation | 0.3210 | | | |
| Level-2 individual initial status | 0.2129 | 2864 | 5367.10 | 0.000 |
| Level-2 individual growth rate | 0.0238 | 2864 | 3911.69 | 0.000 |
| Level-3 school initial status | 0.0061 | 39 | 81.87 | 0.000 |
| Level-3 school growth rate | 0.0007 | 39 | 65.70 | 0.005 |
| **Classroom Activities** | | | | |
| Level-1 temporal variation | 0.4026 | | | |
| Level-2 individual initial status | 0.1696 | 2867 | 4403.13 | 0.000 |
| Level-2 individual growth rate | 0.0060 | 2867 | 3075.13 | 0.004 |
| Level-3 school initial status | 0.0520 | 39 | 274.98 | 0.000 |
| Level-3 school growth rate | 0.0115 | 39 | 321.26 | 0.000 |

(*Continued*)

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

| | | | | |
|---|---|---|---|---|
| **Small-Group Work** | | | | |
| Level-1 temporal variation | 0.4857 | | | |
| Level-2 individual initial status | 0.2520 | 2864 | 4807.28 | 0.000 |
| Level-2 individual growth rate | 0.0268 | 2864 | 3640.40 | 0.000 |
| Level-3 school initial status | 0.0235 | 39 | 132.99 | 0.000 |
| Level-3 school growth rate | 0.0044 | 39 | 122.87 | 0.000 |
| **Technical Problems** | | | | |
| Level-1 temporal variation | 0.5491 | | | |
| Level-2 individual initial status | 0.2410 | 2871 | 4514.92 | 0.000 |
| Level-2 individual growth rate | 0.0264 | 2871 | 3545.61 | 0.000 |
| Level-3 school initial status | 0.0324 | 39 | 176.11 | 0.000 |
| Level-3 school growth rate | 0.0108 | 39 | 233.23 | 0.000 |

Statistical details are provided in Tables E.10, E.11, and E.12 for analyses of mediating variables for Cohort 2. Comparable to Cohort 1, analyses for more complex growth models, including controls for other student demographic variables (gender, ethnicity, home Internet access) yielded immersion growth coefficients nearly identical to those reported in Tables E.10, E.11 and E.12., so results are not provided in this report.

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

| Variable Name | *N* | *Mean*[a] | *SD* |
|---|---|---|---|
| **Repeated Measure Descriptive Statistics (Level 1)** | | | |
| Time | 10,153 | 1.05 | 0.86 |
| Time (SLI) | 8,148 | 1.00 | 0.82 |
| Technology Proficiency score | 9,638 | 3.21 | 0.90 |
| Technology Use in School score | 9,215 | 2.34 | 0.84 |
| Technical Problems score | 9,339 | 2.34 | 0.92 |
| Small-Group Work score | 9,238 | 2.79 to 2.80 | 0.88 |
| School Satisfaction score | 9,345 | 3.71 to 3.72 | 0.74 |
| Self-Directed Learning score | 8,053 | 4.55 | 0.74 |
| **Student-Level Descriptive Statistics (Level 2)** | | | |
| Eco. disadvantaged (1 = yes, 0 = no) | 3,397 | 0.72 | 0.45 |
| Eco. disadvantaged (SLI) | 2,716 | 0.70 | 0.46 |
| **School-Level Descriptive Statistics (Level 3)** | | | |
| Immersion status (1 = yes, 0 = no) | 42 | 0.50 | 0.51 |
| School poverty (proportion) | 42 | 0.70 | 0.17 |

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

**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** | | | | |
| | Initial status (fall 2004) | 2.993 | 0.061 | 49.17*** |
| | Immersion dummy | 0.009 | 0.077 | 0.11 |
| | School poverty | 0.215 | 0.231 | 0.93 |
| | Disadvantaged | -0.290 | 0.043 | -6.75*** |
| | Growth rate | 0.268 | 0.033 | 8.23*** |
| | Immersion dummy | 0.160 | 0.038 | 4.25*** |
| | School poverty | -0.149 | 0.124 | -1.20 |
| | Disadvantaged | 0.006 | 0.032 | 0.20 |
| **Self-Directed Learning** | | | | |
| | Initial status (fall 2004) | 4.787 | 0.053 | 90.41*** |
| | Immersion dummy | -0.070 | 0.064 | -1.10 |
| | School poverty | 0.303 | 0.187 | 1.62 |
| | Disadvantaged | -0.129 | 0.036 | -3.57** |
| | Growth rate | -0.137 | 0.019 | -7.11*** |
| | Immersion dummy | 0.024 | 0.027 | 0.87 |
| | School poverty | -0.026 | 0.082 | -0.32 |
| | Disadvantaged | 0.004 | 0.018 | 0.22 |
| **School Satisfaction** | | | | |
| | Initial status (fall 2004) | 3.865 | 0.035 | 111.65*** |
| | Immersion dummy | 0.034 | 0.043 | 0.79 |
| | School poverty | -0.063 | 0.097 | -0.65 |
| | Disadvantaged | -0.138 | 0.023 | -5.90*** |
| | Growth rate | -0.075 | 0.021 | -3.66** |
| | Immersion dummy | -0.021 | 0.027 | -0.78 |
| | School poverty | 0.077 | 0.057 | 1.34 |
| | Disadvantaged | 0.026 | 0.017 | 1.55 |
| **Classroom Activities** (with technology) | | | | |
| | Initial status (fall 2004) | 2.083 | 0.064 | 32.57*** |
| | Immersion dummy | 0.145 | 0.093 | 1.57 |
| | School poverty | 0.454 | 0.275 | 1.65 |
| | Disadvantaged | -0.013 | 0.039 | -0.34 |
| | Growth rate | 0.059 | 0.042 | 1.40 |
| | Immersion dummy | 0.244 | 0.059 | 4.16*** |
| | School poverty | -0.174 | 0.165 | -1.05 |
| | Disadvantaged | 0.039 | 0.024 | 1.62 |

(*Continued*)

### Table E.11. Immersion (Fixed) Effect Analysis of Student Variables, Cohort 2 (Continued)

| | | | | |
|---|---|---|---|---|
| **Small-Group Work** | | | | |
| | Initial status (fall 2004) | 2.786 | 0.061 | 45.50*** |
| | Immersion dummy | -0.062 | 0.081 | -0.76 |
| | School poverty | 0.144 | 0.177 | 0.81 |
| | Disadvantaged | -0.010 | 0.042 | -0.25 |
| | Growth rate | -0.011 | 0.030 | -0.35 |
| | Immersion dummy | 0.150 | 0.041 | 3.62** |
| | School poverty | -0.023 | 0.115 | -0.20 |
| | Disadvantaged | -0.013 | 0.022 | -0.61 |
| **Technical Problems** | | | | |
| | Initial status (fall 2004) | 2.176 | 0.055 | 39.28*** |
| | Immersion dummy[a] | -0.295 | 0.075 | -3.94*** |
| | School poverty | 0.264 | 0.222 | 1.19 |
| | Disadvantaged | -0.044 | 0.028 | -1.56 |
| | Growth rate | 0.168 | 0.042 | 3.99** |
| | Immersion dummy[a] | 0.072 | 0.048 | 1.50 |
| | School poverty | -0.073 | 0.172 | -0.42 |
| | Disadvantaged | 0.004 | 0.021 | 0.17 |

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

[a] Immersion students had 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 (0.254) and adjusted (0.072) immersion coefficients was significant (the difference divided by the standard error of the difference = 3.32). The growth rate coefficient adjusted for this difference is reported in the table.

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

| Test/ Random Effect | Variance Component | *df* | $X^2$ | *p* |
|---|---|---|---|---|
| **Technology Proficiency** | | | | |
| Level-1 temporal variation | 0.2960 | | | |
| Level-2 individual initial status | 0.4483 | 3299 | 8982.79 | 0.000 |
| Level-2 individual growth rate | 0.0545 | 3299 | 4526.94 | 0.000 |
| Level-3 school initial status | 0.0530 | 39 | 233.90 | 0.000 |
| Level-3 school growth rate | 0.0110 | 39 | 190.34 | 0.000 |
| **Self-Directed Learning** | | | | |
| Level-1 temporal variation | 0.2098 | | | |
| Level-2 individual initial status | 0.3274 | 2673 | 7554.14 | 0.000 |
| Level-2 individual growth rate | 0.0452 | 2673 | 3795.21 | 0.000 |
| Level-3 school initial status | 0.0317 | 39 | 190.37 | 0.000 |
| Level-3 school growth rate | 0.0040 | 39 | 112.78 | 0.000 |
| **School Satisfaction** | | | | |
| Level-1 temporal variation | 0.3429 | | | |
| Level-2 individual initial status | 0.1968 | 3252 | 5296.02 | 0.000 |
| Level-2 individual growth rate | 0.0226 | 3252 | 3663.38 | 0.000 |
| Level-3 school initial status | 0.0096 | 39 | 95.16 | 0.000 |
| Level-3 school growth rate | 0.0037 | 39 | 97.97 | 0.000 |

(*Continued*)

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

| | | | | |
|---|---|---|---|---|
| **Classroom Activities** | | | | |
| Level-1 temporal variation | 0.4291 | | | |
| Level-2 individual initial status | 0.1933 | 3255 | 4861.99 | 0.000 |
| Level-2 individual growth rate | 0.0170 | 3255 | 3491.84 | 0.002 |
| Level-3 school initial status | 0.0811 | 39 | 337.03 | 0.000 |
| Level-3 school growth rate | 0.0334 | 39 | 404.17 | 0.000 |
| **Small-Group Work** | | | | |
| Level-1 temporal variation | 0.5396 | | | |
| Level-2 individual initial status | 0.2229 | 3248 | 4682.94 | 0.000 |
| Level-2 individual growth rate | 0.0358 | 3248 | 3659.85 | 0.000 |
| Level-3 school initial status | 0.0534 | 39 | 224.39 | 0.000 |
| Level-3 school growth rate | 0.0111 | 39 | 145.32 | 0.000 |
| **Technical Problems** | | | | |
| Level-1 temporal variation | 0.4986 | | | |
| Level-2 individual initial status | 0.1920 | 3258 | 4666.88 | 0.000 |
| Level-2 individual growth rate | 0.0605 | 3258 | 4032.74 | 0.000 |
| Level-3 school initial status | 0.0433 | 39 | 214.26 | 0.000 |
| Level-3 school growth rate | 0.0276 | 39 | 269.24 | 0.000 |

**Cohort 3.** 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 3. Statistical details for are provided in Tables E.13, E.14, and E.15.

**Table E.13 Descriptive Statistics for Student Mediating Variables, Cohort 3**

| Variable Name | *N* | *Mean* | *SD* |
|---|---|---|---|
| **Student-Level Descriptive Statistics (Level 1)** | | | |
| Female | 3,980 | 0.51 | 0.50 |
| Hispanic | 3,983 | 0.70 | 0.46 |
| African American | 3,983 | 0.06 | 0.23 |
| Eco. disadvantaged (1 = yes, 0 = no) | 3,969 | 0.73 | 0.44 |
| Technology Proficiency (fall 2006) | 3,893 | 2.89 | 0.90 |
| Technology Proficiency (spring 2007) | 3,927 | 3.28 | 0.85 |
| Self-Directed Learning (fall 2006) | 3,931 | 4.72 | 0.69 |
| Self-Directed Learning (spring 2007) | 3,904 | 4.52 | 0.71 |
| Classroom Activities (fall 2006) | 3,781 | 2.16 | 0.90 |
| Classroom Activities (spring 2007) | 3,892 | 2.41 | 0.84 |
| Technical Problems (fall 2006) | 3,813 | 2.01 | 0.87 |
| Technical Problems (spring 2007) | 3,871 | 2.40 | 0.90 |
| Small-Group Work (fall 2006) | 3,801 | 2.79 | 0.90 |
| Small-Group Work (spring 2007) | 3,835 | 2.80 | 0.87 |
| School Satisfaction (fall 2006) | 3,808 | 3.77 | 0.71 |
| School Satisfaction (spring 2007) | 3,840 | 3.70 | 0.76 |
| **School-Level Descriptive Statistics (Level 2)** | | | |
| Immersion status (1 = yes, 0 = no) | 39 | 0.49 | 0.51 |
| School poverty (proportion) | 39 | 0.69 | 0.17 |

## Table E.14. Immersion (Fixed) Effect Analyses of Student Mediating Variables, Cohort 3

| School-Level Scale | School-Level Analysis | Gamma Coefficient | Standard Error | *t* |
|---|---|---|---|---|
| **Technology Proficiency** | | | | |
| | Base | 3.144 | 0.051 | 62.11*** |
| | Immersion dummy | 0.330 | 0.050 | 6.56*** |
| | School poverty | -0.345 | 0.139 | -2.48* |
| | Female | 0.085 | 0.028 | 3.09** |
| | Hispanic | -0.012 | 0.032 | -0.37 |
| | African American | -0.024 | 0.039 | -0.60 |
| | Disadvantaged | -0.073 | 0.044 | -1.66 |
| | Fall 2006 score | 0.526 | 0.023 | 23.36*** |
| **Self-Directed Learning** | | | | |
| | Base | 4.468 | 0.045 | 99.06*** |
| | Immersion dummy | 0.056 | 0.042 | 1.32 |
| | School poverty | 0.067 | 0.131 | 0.51 |
| | Female | 0.073 | 0.023 | 3.22** |
| | Hispanic | 0.017 | 0.045 | 0.38 |
| | African American | 0.094 | 0.043 | 2.16* |
| | Disadvantaged | -0.036 | 0.019 | -1.90 |
| | Fall 2006 score | 0.571 | 0.022 | 25.39*** |
| **School Satisfaction** | | | | |
| | Base | 3.625 | 0.047 | 77.67*** |
| | Immersion dummy | 0.068 | 0.039 | 1.75 |
| | School poverty | 0.075 | 0.157 | 0.48 |
| | Female | 0.120 | 0.023 | 5.27*** |
| | Hispanic | 0.026 | 0.046 | 0.57 |
| | African American | -0.017 | 0.060 | -0.29 |
| | Disadvantaged | -0.038 | 0.035 | -1.09 |
| | Fall 2006 score | 0.396 | 0.032 | 12.49*** |
| **Classroom Activities** | | | | |
| (with technology) | Base | 1.998 | 0.056 | 35.66*** |
| | Immersion dummy | 0.610 | 0.072 | 8.51*** |
| | School poverty | -0.174 | 0.228 | -0.76 |
| | Female | 0.004 | 0.023 | 0.18 |
| | Hispanic | 0.046 | 0.029 | 1.57 |
| | African American | 0.138 | 0.058 | 2.38* |
| | Disadvantaged | 0.112 | 0.031 | 3.66** |
| | Fall 2006 score | 0.257 | 0.025 | 10.28*** |
| **Small-Group Work** | | | | |
| | Base | 2.542 | 0.055 | 46.54*** |
| | Immersion dummy | 0.305 | 0.073 | 4.19*** |
| | School poverty | 0.060 | 0.210 | 0.28 |
| | Female | 0.076 | 0.022 | 3.50** |
| | Hispanic | 0.044 | 0.034 | 1.30 |
| | African American | 0.207 | 0.042 | 4.88*** |
| | Disadvantaged | 0.059 | 0.041 | 1.44 |
| | Fall 2006 score | 0.254 | 0.016 | 15.65*** |
| **Technical Problems** | | | | |
| | Base | 2.243 | 0.072 | 31.22*** |
| | Immersion dummy | 0.209 | 0.079 | 2.65* |
| | School poverty | 0.058 | 0.258 | 0.23 |
| | Female | 0.034 | 0.029 | 1.17 |
| | Hispanic | 0.008 | 0.052 | 0.15 |
| | African American | 0.007 | 0.058 | 0.11 |
| | Disadvantaged | -0.010 | 0.036 | -0.29 |
| | Fall 2006 score | 0.224 | 0.026 | 8.48*** |

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

**Table E.15. Variance Decomposition from Conditional HLM Models of Student Mediating Variables, Cohort 3**

| Test/ Random Effect | Variance Component | *df* | $X^2$ | *p* |
|---|---|---|---|---|
| **Technology Proficiency** | | | | |
| Level-1 student effect | 0.4520 | | | |
| School mean | 0.0198 | 36 | 160.77 | 0.000 |
| School pretest-outcome slope | 0.0109 | 38 | 90.61 | 0.000 |
| **Self-Directed Learning** | | | | |
| Level-1 student effect | 0.3233 | | | |
| School mean | 0.0179 | 35 | 163.53 | 0.000 |
| School pretest-outcome slope | 0.0104 | 37 | 89.71 | 0.000 |
| **School Satisfaction** | | | | |
| Level-1 student effect | 0.4779 | | | |
| School mean | 0.0095 | 36 | 89.07 | 0.000 |
| School pretest-outcome slope | 0.0214 | 38 | 102.57 | 0.000 |
| **Classroom Activities** | | | | |
| Level-1 student effect | 0.4916 | | | |
| School mean | 0.0468 | 36 | 228.26 | 0.000 |
| School pretest-outcome slope | 0.0112 | 38 | 100.18 | 0.000 |
| **Small-Group Work** | | | | |
| Level-1 student effect | 0.6542 | | | |
| School mean | 0.0455 | 36 | 197.77 | 0.000 |
| School pretest-outcome slope | Effect not random | | | |
| **Technical Problems** | | | | |
| Level-1 student effect | 0.7030 | | | |
| School mean | 0.0631 | 36 | 235.59 | 0.000 |
| School pretest-outcome slope | 0.0122 | 38 | 71.58 | 0.001 |

### *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.16, E.17, and E.18.

## Table E.16. Descriptive Statistics for Student Attendance

| Variable Name | *N* | *Mean* | *SD* |
|---|---|---|---|
| **Cohort 1 Repeated Measures Descriptive Statistics (Level 1)** | | | |
| Year | 16,680 | 1.50 | 1.12 |
| Attendance | 16,577 | 96.69 | 4.08 |
| **Cohort 2 Repeated Measures Descriptive Statistics (Level 1)** | | | |
| Year | 14,277 | 1.00 | 0.82 |
| Attendance | 14,130 | 96.64 | 4.11 |
| **Cohort 1 Student-Level Descriptive Statistics (Level 2)** | | | |
| Eco. disadvantaged (1 = yes, 0 = no) | 4,170 | 0.74 | 0.44 |
| **Cohort 2 Student-Level Descriptive Statistics (Level 2)** | | | |
| Eco. disadvantaged (1 = yes, 0 = no) | 4,759 | 0.75 | 0.43 |
| **Cohort 3 Student-Level Descriptive Statistics (Level 1)** | | | |
| Attendance 2007 | 5,205 | 96.41 | 4.14 |
| Attendance 2006 | 5,078 | 97.03 | 3.52 |
| Eco. disadvantaged (1 = yes, 0 = no) | 5,205 | 0.76 | 0.42 |
| Hispanic (1 = yes, 0 = no) | 5,205 | 0.73 | 0.44 |
| African American (1 = yes, 0 = no) | 5,205 | 0.06 | 0.23 |
| Female (1 = yes, 0 = no) | 5,205 | 0.49 | 0.50 |
| **Cohorts 1, 2, and 3 School-Level Descriptive Statistics** | | | |
| Immersion status (1 = yes, 0 = no) | 42 | 0.50 | 0.51 |
| School poverty (proportion) | 42 | 0.70 | 0.17 |

## Table E.17. Immersion (Fixed) Effect Analyses of Student Attendance

| Group | School-Level Analysis | Gamma Coefficient | Standard Error | *t* |
|---|---|---|---|---|
| **Cohort 1** | | | | |
| **3-Level HLM Growth Model** | Initial attendance (2004) | 97.706 | 0.172 | 567.25*** |
| | Immersion dummy | -0.045 | 0.242 | -0.19 |
| | School poverty | 2.230 | 0.627 | 3.56** |
| | Eco. disadvantaged | -0.651 | 0.172 | -3.79*** |
| | Growth rate | -0.165 | 0.061 | -2.72* |
| | Immersion dummy | -0.272 | 0.090 | -3.04** |
| | School poverty | -0.260 | 0.249 | -1.05 |
| | Eco. disadvantaged | -0.119 | 0.059 | -2.03* |
| **Cohort 2** | | | | |
| **3-Level HLM Growth Model** | Initial attendance (2004) | 97.518 | 0.145 | 671.67*** |
| | Immersion dummy | -0.262 | 0.185 | -1.41 |
| | School poverty | 1.550 | 0.572 | 2.71* |
| | Eco. disadvantaged | -0.487 | 0.136 | -3.59** |
| | Growth rate | -0.120 | 0.087 | -1.38 |
| | Immersion dummy | -0.249 | 0.109 | -2.28* |
| | School poverty | -0.437 | 0.276 | -1.59 |
| | Eco. disadvantaged | -0.309 | 0.073 | -4.26*** |
| **Cohort 3** | | | | |
| **2-Level HLM Model** | Base | 96.886 | 0.201 | 482.35*** |
| | Immersion dummy | -0.564 | 0.211 | -2.67* |
| | School poverty | 0.393 | 0.598 | 0.66 |
| | Female | 0.204 | 0.104 | 1.96* |
| | African American | 0.382 | 0.242 | 1.58 |
| | Hispanic | 0.262 | 0.172 | 1.53 |
| | Eco. disadvantaged | -0.543 | 0.115 | -4.74*** |
| | Prior attendance | 0.622 | 0.037 | 17.00*** |

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

**Table E.18. Variance Decomposition from Conditional HLM Models of Student attendance, Cohorts 1, 2, and 3**

| Cohort/<br>Random Effect | Variance Component | *df* | $X^2$ | *pt* |
|---|---|---|---|---|
| **Cohort 1** | | | | |
| Level-1 temporal variation | 4.8370 | | | |
| Level-2 individual initial status | 6.1984 | 4127 | 11612.89 | 0.000 |
| Level-2 individual growth rate | 1.1460 | 4127 | 8997.61 | 0.000 |
| Level-3 school initial status | 0.4884 | 39 | 227.83 | 0.000 |
| Level-3 school growth rate | 0.0546 | 39 | 136.99 | 0.000 |
| **Cohort 2** | | | | |
| Level-1 temporal variation | 4.9373 | | | |
| Level-2 individual initial status | 7.3931 | 4716 | 13066.95 | 0.000 |
| Level-2 individual growth rate | 1.6743 | 4716 | 7924.01 | 0.000 |
| Level-3 school initial status | 0.1766 | 39 | 105.74 | 0.000 |
| Level-3 school growth rate | 0.0670 | 39 | 100.96 | 0.000 |
| **Cohort 3** | | | | |
| Level-1 student effect | 10.6080 | | | |
| School mean | 0.5631 | 39 | 222.34 | 0.000 |
| School pre-measure-outcome slope | 0.0410 | 41 | 322.08 | 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 (eighth graders) in Tables E.19 through E.22, for Cohort 2 (seventh graders) in Tables E.23 through E.26, and for Cohort 3 students (sixth graders) in Tables E.27 through E.29.

### *Cohort 1 (Eighth Graders)*

**Table E.19. Descriptive Statistics for TAKS Reading and Mathematics, Cohort 1**

| Variable Name | *N* | *Mean* | *SD* |
|---|---|---|---|
| **Repeated Measures Descriptive Statistics: Reading (Level 1)** | | | |
| Time | 11,972 | 1.50 | 1.12 |
| TAKS Reading T score | 11,972 | 48.93 | 9.40 |
| **Repeated Measures Descriptive Statistics: Mathematics (Level 1)** | | | |
| Time | 12,052 | 1.50 | 1.12 |
| TAKS Mathematics T score | 12,052 | 49.15 | 9.48 |
| **Student-Level Descriptive Statistics: Reading (Level 2)** | | | |
| Eco. disadvantaged (1 = yes, 0 = no) | 2,993 | 0.70 | 0.46 |
| **Student-Level Descriptive Statistics: Mathematics (Level 2)** | | | |
| Eco. disadvantaged (1 = yes, 0 = no) | 3,013 | 0.70 | 0.46 |
| **School-Level Descriptive Statistics (Level 3)** | | | |
| Immersion status (1 = yes, 0 = no) | 42 | 0.50 | 0.51 |
| School poverty (proportion) | 42 | 0.70 | 0.17 |

**Table E.20. Descriptive Statistics for TAKS Science and Social Studies, Cohort 1**

| Variable Name | *N* | *Mean* | *SD* |
|---|---|---|---|
| **Student-Level Descriptive Statistics: Science (Level 1)** | | | |
| Female | 2,967 | 0.53 | 0.50 |
| African American | 2,967 | 0.05 | 0.23 |
| Hispanic | 2,967 | 0.69 | 0.46 |
| Eco. disadvantaged (1 = yes, 0 = no) | 2,967 | 0.69 | 0.46 |
| TAKS Science T score (2004) | 2,967 | 49.51 | 9.17 |
| TAKS Science T score (2007) | 2,967 | 48.93 | 9.00 |
| **Student-Level Descriptive Statistics: Social Studies (Level 1)** | | | |
| Female | 3,143 | 0.52 | 0.50 |
| African American | 3,143 | 0.05 | 0.23 |
| Hispanic | 3,143 | 0.69 | 0.46 |
| Eco. disadvantaged (1 = yes, 0 = no) | 3,143 | 0.70 | 0.46 |
| TAKS Reading T score (2006) | 3,143 | 48.77 | 9.77 |
| TAKS Social Studies T score (2007) | 3,143 | 48.86 | 8.23 |
| **School-Level Descriptive Statistics (Level 2)** | | | |
| Immersion status (1 = yes, 0 = no) | 42 | 0.50 | 0.51 |
| School poverty (percent) | 42 | 0.70 | 0.17 |

**Table E.21. 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) | 54.002 | 0.702 | 76.89*** |
| | Immersion dummy[a] | -1.346 | 0.713 | -1.89† |
| | School poverty | -6.504 | 1.449 | -4.49*** |
| | Eco. disadvantaged | -6.170 | 0.657 | -9.40*** |
| | Growth rate | -0.369 | 0.129 | -2.86** |
| | Immersion dummy[a] | 0.212 | 0.146 | 1.45 |
| | School poverty | 0.860 | 0.493 | 1.75† |
| | Eco. disadvantaged | 0.536 | 0.132 | 4.07*** |
| **Mathematics** | | | | |
| | Initial status (spring 2004) | 53.019 | 0.749 | 70.83*** |
| | Immersion dummy | -1.201 | 0.882 | -1.36 |
| | School poverty | -4.724 | 1.888 | -2.50* |
| | Eco. disadvantaged | -4.487 | 0.521 | -8.60*** |
| | Growth rate | -0.181 | 0.157 | -1.15 |
| | Immersion dummy | 0.582 | 0.298 | 1.95† |
| | School poverty | 1.488 | 0.892 | 1.67 |
| | Eco. disadvantaged | 0.025 | 0.086 | 0.29 |
| | Immersion dummy | -0.408 | 0.215 | -1.90† |
| **Science** | | | | |
| | Base | 52.269 | 0.569 | 91.89*** |
| | Immersion dummy | -0.238 | 0.668 | -0.36 |
| | School poverty | 0.167 | 1.830 | 0.09 |
| | Female | -1.203 | 0.204 | -5.90*** |
| | African American | -2.052 | 0.797 | -2.57* |
| | Hispanic | -1.712 | 0.383 | -4.47*** |
| | Eco. disadvantaged | -1.518 | 0.344 | -4.41*** |
| | Spring 2004 T score | 0.681 | 0.029 | 23.72*** |
| | Immersion dummy | -0.084 | 0.044 | -1.90† |

(*Continued*)

### Table E.21. Immersion (Fixed) Effect Analyses of TAKS Achievement, Cohort 1 (Continued)

| | | | | |
|---|---|---|---|---|
| **Social Studies** | | | | |
| | Base | 49.525 | 1.078 | 45.93*** |
| | Immersion dummy | 0.574 | 0.603 | 0.95 |
| | School poverty | 4.607 | 1.658 | 2.78** |
| | Female | -2.537 | 0.246 | -10.32*** |
| | African American | -1.851 | 0.349 | -5.31*** |
| | Hispanic | -2.033 | 0.510 | -3.99*** |
| | Eco. disadvantaged | -1.614 | 0.371 | -4.35*** |
| | Spr. 2006 reading T score | 0.539 | 0.015 | 35.30*** |

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

[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 =1.30).

### Table E.22. 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 | 23.4384 | | | |
| Level-2 individual initial status | 57.6673 | 2950 | 13315.15 | 0.000 |
| Level-2 individual growth rate | 0.2738 | 2950 | 3117.01 | 0.016 |
| Level-3 school initial status | 3.6305 | 39 | 171.19 | 0.000 |
| Level-3 school growth rate | 0.1255 | 39 | 111.71 | 0.000 |
| **Mathematics** | | | | |
| Level-1 temporal variation | 20.1761 | | | |
| Level-2 individual initial status | 58.2327 | 2970 | 15210.61 | 0.000 |
| Level-2 individual growth rate | 0.7539 | 2970 | 3525.93 | 0.000 |
| Level-3 school initial status | 6.3585 | 39 | 230.66 | 0.000 |
| Level-3 school growth rate | 0.7278 | 39 | 351.79 | 0.000 |
| **Science** | | | | |
| Level-1 student effect | 34.0990 | | | |
| School mean | 4.1842 | 39 | 213.97 | 0.000 |
| School pre-measure-outcome slope | 0.0116 | 40 | 94.70 | 0.000 |
| **Social Studies** | | | | |
| Level-1 student effect | 30.8751 | | | |
| School mean | 3.8495 | 39 | 280.04 | 0.000 |
| School pre-measure-outcome slope | 0.0047 | 41 | 75.56 | 0.001 |

### *Cohort 2 (Seventh Graders)*

**Table E.23 Descriptive Statistics for TAKS Reading and Mathematics, Cohort 2**

| Variable Name | *N* | *Mean* | *SD* |
|---|---:|---:|---:|
| **Repeated Measures Descriptive Statistics: Reading (Level 1)** | | | |
| Time | 9,813 | 1.00 | 0.82 |
| TAKS Reading T score | 9,813 | 48.73 | 9.48 |
| **Repeated Measures Descriptive Statistics: Mathematics (Level 1)** | | | |
| Time | 9,930 | 1.00 | 0.82 |
| TAKS Mathematics T score | 9,930 | 48.53 | 9.30 |
| **Student-Level Descriptive Statistics: Reading (Level 2)** | | | |
| Eco. disadvantaged (1 = yes, 0 = no) | 3,271 | 0.70 | 0.46 |
| **Student-Level Descriptive Statistics: Mathematics (Level 2)** | | | |
| Eco. disadvantaged (1 = yes, 0 = no) | 3,310 | 0.70 | 0.46 |
| **School-Level Descriptive Statistics (Level 3)** | | | |
| Immersion status (1 = yes, 0 = no) | 42 | 0.50 | 0.51 |
| School poverty (proportion) | 42 | 0.70 | 0.17 |

**Table E.24. Descriptive Statistics for TAKS Writing, Cohort 2**

| Variable Name | *N* | *Mean* | *SD* |
|---|---:|---:|---:|
| **Student-Level Descriptive Statistics : Writing (Level 1)** | | | |
| Female | 3,088 | 0.52 | 0.50 |
| African American | 3,088 | 0.07 | 0.26 |
| Hispanic | 3,088 | 0.68 | 0.47 |
| Eco. disadvantaged (1 = yes, 0 = no) | 3,088 | 0.69 | 0.46 |
| TAKS Writing T score (2004) | 3,088 | 49.89 | 9.39 |
| TAKS Writing T score (2007) | 3,088 | 49.88 | 7.53 |
| **School-Level Descriptive Statistics (Level 2)** | | | |
| Immersion status (1 = yes, 0 = no) | 42 | 0.50 | 0.51 |
| School poverty (percent) | 42 | 0.70 | 0.17 |

### Table E.25. Immersion (Fixed) Effect Analyses of TAKS Achievement, Cohort 2

| TAKS Achievement Test | School-Level Analysis | Gamma Coefficient | Standard Error | *t*-value |
|---|---|---|---|---|
| **Reading** | | | | |
| | Initial status (spring 2005) | 52.770 | 0.523 | 100.87*** |
| | Immersion dummy | -0.488 | 0.601 | -0.81 |
| | School poverty | -8.049 | 1.396 | -5.77*** |
| | Eco. disadvantaged | -5.511 | 0.591 | -9.33*** |
| | Growth rate | -0.155 | 0.182 | -0.85 |
| | Immersion dummy | 0.388 | 0.233 | 1.66 |
| | School poverty | 0.905 | 0.694 | 1.30 |
| | Eco. disadvantaged | 0.283 | 0.182 | 1.56 |
| **Mathematics** | | | | |
| | Initial status (spring 2005) | 52.306 | 0.547 | 95.59*** |
| | Immersion dummy | -1.029 | 0.667 | -1.54 |
| | School poverty | -4.373 | 1.832 | -2.39* |
| | Eco. disadvantaged | -4.492 | 0.576 | -7.80*** |
| | Growth rate | -0.444 | 0.270 | -1.65 |
| | Immersion dummy | 0.708 | 0.398 | 1.78† |
| | School poverty | 0.317 | 1.022 | 0.31 |
| | Eco. disadvantaged | 0.044 | 0.180 | 0.24 |
| **Writing** | | | | |
| | Base | 51.181 | 0.510 | 100.44*** |
| | Immersion dummy | -0.283 | 0.428 | -0.66 |
| | School poverty | 0.315 | 1.323 | 0.24 |
| | Female | 1.409 | 0.237 | 5.94*** |
| | African American | -1.141 | 0.387 | -2.95** |
| | Hispanic | -1.355 | 0.303 | -4.47*** |
| | Eco. disadvantaged | -1.210 | 0.360 | -3.36** |
| | Spring 2004 T score | 0.453 | 0.016 | 28.59*** |

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

### Table E.26. Variance Decomposition from Conditional HLM Models of Student Achievement, Cohort 2

| Test/ Random Effect | Variance Component | *df* | $X^2$ | *p* |
|---|---|---|---|---|
| **Reading** | | | | |
| Level-1 temporal variation | 26.0638 | | | |
| Level-2 individual initial status | 50.0343 | 3228 | 21858.54 | 0.000 |
| Level-2 individual growth rate | Effect not random | | | |
| Level-3 school initial status | 1.9434 | 39 | 145.61 | 0.000 |
| Level-3 school growth rate | 0.3064 | 39 | 111.80 | 0.000 |
| **Mathematics** | | | | |
| Level-1 temporal variation | 19.5682 | | | |
| Level-2 individual initial status | 54.9601 | 3267 | 14297.70 | 0.000 |
| Level-2 individual growth rate | 1.5537 | 3267 | 3786.90 | 0.000 |
| Level-3 school initial status | 3.0190 | 39 | 190.90 | 0.000 |
| Level-3 school growth rate | 1.4050 | 39 | 481.48 | 0.000 |
| **Writing** | | | | |
| Level-1 student effect | 31.3854 | | | |
| School mean | 1.6384 | 38 | 151.64 | 0.000 |
| School pre-measure-outcome slope | 0.0043 | 40 | 71.98 | 0.002 |

## *Cohort 3 (Sixth Graders)*

### Table E.27. Descriptive Statistics for TAKS Achievement, Cohort 3

| Variable Name | *N* | *Mean* | *SD* |
|---|---|---|---|
| **Student-Level Descriptive Statistics: Reading (Level 1)** | | | |
| Female | 3,769 | 0.52 | 0.50 |
| African American | 3,769 | 0.06 | 0.24 |
| Hispanic | 3,769 | 0.70 | 0.46 |
| Eco. disadvantaged (1 = yes, 0 = no) | 3,753 | 0.72 | 0.45 |
| TAKS Reading T score (2006) | 3,769 | 49.28 | 9.62 |
| TAKS Reading T score (2007) | 3,769 | 48.62 | 7.74 |
| **Student-Level Descriptive Statistics : Mathematics (Level 1)** | | | |
| Female | 3,813 | 0.51 | 0.50 |
| African American | 3,813 | 0.06 | 0.24 |
| Hispanic | 3,813 | 0.70 | 0.46 |
| Eco. disadvantaged (1 = yes, 0 = no) | 3,797 | 0.72 | 0.45 |
| TAKS Mathematics T score (2006) | 3,813 | 49.44 | 9.48 |
| TAKS Mathematics T score (2007) | 3,813 | 48.51 | 8.72 |
| **School-Level Descriptive Statistics (Level 2)** | | | |
| Immersion status (1 = yes, 0 = no) | 42 | 0.50 | 0.51 |
| School poverty (proportion) | 42 | 0.70 | 0.17 |

### Table E.28. Immersion (Fixed) Effect Analyses of Cohort 3 Achievement

| TAKS Achievement Test | School-Level Analysis | Gamma Coefficient | Standard Error | *t*-value |
|---|---|---|---|---|
| **Reading** | | | | |
| | Base | 49.140 | 0.337 | 145.71*** |
| | Immersion dummy | 0.082 | 0.249 | 0.33 |
| | School poverty | 1.591 | 0.874 | 1.82† |
| | Female | 1.385 | 0.187 | 7.41*** |
| | African American | -1.486 | 0.352 | -4.23*** |
| | Hispanic | -1.075 | 0.277 | -3.88** |
| | Eco. disadvantaged | -0.539 | 0.192 | -2.81** |
| | Spring 2006 T score | 0.523 | 0.015 | 34.72*** |
| **Mathematics** | | | | |
| | Base | 48.799 | 0.491 | 99.43*** |
| | Immersion dummy | 0.282 | 0.640 | 0.44 |
| | School poverty | 0.265 | 1.661 | 0.16 |
| | Female | 0.944 | 0.233 | 4.05*** |
| | African American | -1.309 | 0.355 | -3.69** |
| | Hispanic | -0.486 | 0.244 | -1.99* |
| | Eco. disadvantaged | -1.064 | 0.252 | -4.23*** |
| | Spring 2006 T score | 0.608 | 0.021 | 28.98*** |
| | Immersion dummy | 0.082 | 0.024 | 3.41** |

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

## Table E.29. Variance Decomposition from Conditional HLM Models of Student Achievement, Cohort 3

| Test/ Random Effect | Variance Component | *df* | $X^2$ | *p* |
|---|---|---|---|---|
| **Reading** | | | | |
| Level-1 student effect | 28.2895 | | | |
| School mean | 1.1674 | 39 | 188.84 | 0.000 |
| School pre-measure-outcome slope | 0.0045 | 41 | 99.62 | 0.000 |
| **Mathematics** | | | | |
| Level-1 student effect | 33.7924 | | | |
| School mean | 4.1607 | 39 | 469.85 | 0.000 |
| School pre-measure-outcome slope | 0.0018 | 40 | 57.07 | 0.039 |

# Appendix F

## Effects of Technology Immersion on Schools

On one part of the 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 (0.97).

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, second, and third 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 stronger technology supports than teachers at control campuses. Data from analyses of school variables, summarized in Table F.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 items measuring their levels of agreement with the provision of four school-level supports for technology. However, at the end of the third year of implementation (spring 2007), there were no significant differences between immersion and control teachers on Leadership and Technical Support, and smaller significant differences on Teacher Support and Parent and Community Support.

- Leadership (Effect sizes = 0.42 and 0.35, respectively, in spring 2005 and 2006, but only 0.03 in spring 2007),
- Teacher Support (Effect sizes = 0.43, 0.40, and 0.27, respectively, in spring 2005, 2006, and 2007),
- Parent and Community Support (Effect sizes = 0.51, 0.24, and 0.16, respectively, in spring 2005, 2006, and 2007), and
- Technical Support (Effect sizes = 0.33, 0.20, and 0.07, respectively, in spring 2005, 2006, and 2007).

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 administrators establish a clear vision and expectations for technology, encourage classroom integration, provide needed supports, and involve staff in decision making. Results show that in the fall of 2004, teachers at immersion schools reported significantly higher Leadership scores for their administrators than control teachers ($M$ = 3.70 vs. 3.60, ES = 0.16). This may have reflected teachers' initial optimism about their administrators' 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 = 0.42), and their higher estimations of administrative leadership, compared to control teachers, was sustained at the end of the second year (ES = 0.35). However, at the end of the third year, more teachers at control schools tended to *agree* that their administrators provided technology-related support, and there were essentially no differences between the two groups ($M$ = 3.90 versus 3.88, ES = 0.03). This improvement in control teachers' perceptions of technology-related leadership may reflect the emphasis on technology at their campuses. Most control campuses began planning to implement technology immersion during the next school year in at least one grade level. As part of preparations for immersion, many control teachers received laptop computers, electronic resources, and technology-related professional development during the 2006-07 school year.

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

| School Variables | Immersion *N* =21 Mean | Immersion *N* =21 *SD* | Control *N*=21 Mean | Control *N*=21 *SD* | *t*-value | *p* | Effect Size |
|---|---|---|---|---|---|---|---|
| **Leadership** | | | | | | | |
| Fall 2004 | 3.70 | 0.61 | 3.60 | 0.67 | 2.84 | 0.005* | 0.16 |
| Spring 2005 | 3.88 | 0.62 | 3.61 | 0.67 | 6.74 | 0.000* | 0.42 |
| Spring 2006 | 3.89 | 0.65 | 3.64 | 0.76 | 5.78 | 0.000* | 0.35 |
| Spring 2007 | 3.90 | 0.73 | 3.88 | 0.68 | 0.64 | 0.521 | 0.03 |
| **Teacher Support (for innovation)** | | | | | | | |
| Fall 2004 | 3.72 | 0.66 | 3.71 | 0.67 | 0.23 | 0.817 | 0.02 |
| Spring 2005 | 4.00 | 0.60 | 3.73 | 0.65 | 6.94 | 0.000* | 0.43 |
| Spring 2006 | 4.06 | 0.62 | 3.80 | 0.68 | 6.54 | 0.000* | 0.40 |
| Spring 2007 | 4.09 | 0.63 | 3.92 | 0.68 | 4.46 | 0.000* | 0.26 |
| **Parent and Community Support** | | | | | | | |
| Fall 2004 | 3.44 | 0.78 | 3.39 | 0.74 | 1.10 | 0.273 | 0.07 |
| Spring 2005 | 3.75 | 0.71 | 3.38 | 0.74 | 8.05 | 0.000* | 0.51 |
| Spring 2006 | 3.64 | 0.82 | 3.44 | 0.85 | 3.89 | 0.000* | 0.24 |
| Spring 2007 | 3.69 | 0.88 | 3.56 | 0.79 | 2.86 | 0.004* | 0.16 |
| **Technical Support** | | | | | | | |
| Fall 2004 | 3.29 | 0.75 | 3.31 | 0.76 | -0.45 | 0.654 | -0.03 |
| Spring 2005 | 3.60 | 0.69 | 3.36 | 0.76 | 5.12 | 0.000* | 0.33 |
| Spring 2006 | 3.63 | 0.67 | 3.49 | 0.70 | 3.34 | 0.001* | 0.20 |
| Spring 2007 | 3.70 | 0.71 | 3.65 | 0.71 | 1.06 | 0.289 | 0.07 |

*Notes.* Scale scores range from 1.00 to 5.00. Fall 2004: *N*=524 to 533 immersion teachers, *N*=601 to 606 control teachers; spring 2005: *N*=468 to 481 immersion teachers and *N*=521 to 541 control teachers; spring 2006: *N*=507 to 519 immersion teachers and *N*=574 to 584 control teachers; spring 2007: *N*=570 to 584 immersion teachers and *N*=610 to 624 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. Port Arthur campuses were excluded.

### 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, 0.40, and 0.26, respectively, in 2005, 2006, and 2007). 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). Third year data show even smaller significant differences between immersion and control teachers (ES = 0.16). During the third year, control teachers' scores increased more than did immersion teachers' scores. This may also be due to many control campuses being in the planning phase for technology immersion.

### 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). Yet with control schools ramping up their technology preparation in the third year, there were no significant differences between immersion and control teachers' perceived technical support ($M$ = 3.70 immersion versus 3.65 control, ES = 0.07).

In sum, after the first and second years of the pilot project, teachers at immersion schools compared to control perceived stronger school-level organizational supports for technology from administrators, 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 after the third project year. This reflects the immersion planning process going on at most control campuses in preparation for giving laptops to students in at least one grade level during the next school year.

An additional, longitudinal analysis for teachers who were in the immersion project from fall 2004 through spring 2007 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 also revealed statistically significant increases for all of the school-level indicators (see Table F.2).

### Table F.2. School Variables for Immersed and Control Teachers in Fall 2004 and Spring 2007

| School Variables | *N* | Fall 2004 | | Spring 2007 | | *t*-value | *p* |
|---|---|---|---|---|---|---|---|
| | | Mean | *SD* | Mean | *SD* | | |
| **Immersion** | | | | | | | |
| Leadership and System Support | 314 | 3.73 | 0.60 | 3.90 | 0.74 | 3.78 | 0.000* |
| Technical Support | 306 | 3.25 | 0.72 | 3.68 | 0.73 | 8.86 | 0.000* |
| Innovative Culture | 305 | 3.76 | 0.62 | 4.11 | 0.62 | 7.77 | 0.000* |
| Parent and Community Support | 314 | 3.42 | 0.78 | 3.69 | 0.90 | 5.14 | 0.000* |
| **Control** | | | | | | | |
| Leadership and System Support | 375 | 3.60 | 0.68 | 3.82 | 0.72 | 5.73 | 0.000* |
| Technical Support | 366 | 3.31 | 0.75 | 3.66 | 0.72 | 8.27 | 0.000* |
| Innovative Culture | 367 | 3.71 | 0.66 | 3.90 | 0.68 | 5.07 | 0.000* |
| Parent and Community Support | 371 | 3.42 | 0.73 | 3.54 | 0.84 | 3.04 | 0.003* |

*Notes.* Score range is from 1.00 to 5.00. Port Arthur campuses were excluded.

*Statistically significant difference.