The Apple and ConnectED Initiative:

Research Study Methods

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Introduction

In 2014, Apple embarked on a nationwide initiative to bring substantively new and deeper learning opportunities to students in schools and communities across the country with the greatest need. The Apple and ConnectED Initiative offered its participating schools a comprehensive set of tools and services, including an iPad® for every student, technology for every teacher, infrastructure upgrades, and substantial professional support. The initiative was designed to leverage Apple's long history of supporting innovative technology use in the classroom to make a meaningful difference for children who have historically lacked access to equitable learning opportunities.

Over the ensuing six years, SRI International (SRI) has conducted a rigorous program of research on the implementation of the Apple and ConnectED Initiative and its outcomes for participating students, teachers, classrooms, and communities. The 114 schools served by the initiative range from pre-K to secondary, and each serves a high majority (96% or higher) of students receiving free and reduced-price lunch. The breadth and scale of the initiative offered a unique opportunity to explore the varied trajectories of 1:1 iPad adoption over time, the opportunities for substantive instructional improvement that it may represent in a very diverse set of under-resourced community settings, and what it takes to succeed.

This report describes the research design of the Apple and ConnectED Initiative, beginning with discussions of the theory of change and the conceptual framework that ground the research and an introduction to the Apple and ConnectED Initiative that provides the research's focus. The report then describes the research design and methodology, which employ complementary substudies to create a study that is both broad and deep. The substudies include:

- **Surveys** of teachers, principals, and students
- **Case studies** of selected schools
- **Analysis of lessons and student work** to determine opportunities for deeper learning
- **A student achievement study** that uses state test data to investigate student learning outcomes

This report is intended for researchers and other technical audiences interested in understanding the methodological details that underly the Apple and ConnectED Research study. It complements a series of reports that present study results and discuss findings.

Theory of Change and Conceptual Framework

In designing the Apple and ConnectED Initiative, Apple sought to build on lessons learned over many years of work in classrooms to embed the elements of process and support they believed to be essential as schools and teachers navigate the myriad opportunities and challenges of 1:1 technology adoption.

The theory of change that summarizes the initiative's strategies, activities, and target outcomes is shown in the appendix of this report. Important elements include the following:

- **Context.** Apple's initiative began as part of the national ConnectED initiative promoted by the White House in 2013, in which companies pledged investments to help connect schools and students in low-income communities to the internet and the learning opportunities it brings. For the Apple and ConnectED Initiative, salient elements of context include the social and educational needs in the communities where the initiative operates. An important criterion for schools chosen for the initiative was that a minimum of 96% of students were eligible for free and reduced-price lunch, placing them among the neediest in the nation.[1]
- **Design principles.** A number of Apple's experience-based convictions about successful school transformation grounded the specific design of the initiative. These include the beliefs that the successful integration of technology into instruction requires substantial human support; each school is expected to follow its own path and pace, and should be supported to do so; certain elements of leadership and infrastructure readiness must be in place before proceeding with technology integration; and technology, not an end in itself, is an enabler for achieving the primary goal of transforming learning and teaching for all students.
- **Apple Model of School Transformation and conditions for progress.** The initiative began with dedicated support for school leaders, teachers, and information technology (IT) staff from experienced educators and technical specialists on Apple's staff who develop customized rollout and support plans with each school. School plans were rolled out in a series of phases, with each phase creating the conditions that would enable the following phase of work. The intent was that before student devices were delivered, both technical and human readiness would be established so that early classroom use could be productive.
- **Dimensions of change.** The suite of support was designed to produce a set of effects in schools, including visionary leadership and transformations of teaching and learning, which Apple has found to be hallmarks of successful iPad-supported schools.

[1] Other selection criteria included visionary leadership—seen as an essential ingredient for successful school change—and promising plans for teaching and learning, a concept for a digital learning environment, and other elements of the vision.

- **Outcomes.** The theory of change describes the intended outcomes of the program, both short-term (observable within the duration of the program) and long-term (emergent over time), and denotes outcomes considered high priority by initiative leaders, including outcomes for students, teachers, school leaders, families, and community.
- **Trajectory.** The appendix also describes the expected trajectory for emerging outcomes. Based on Apple's experience, the early days of iPad use in ConnectED classrooms were expected to be characterized by high degrees of student engagement and frequent use of the devices in learning. More substantive changes to teaching, learning opportunities, and student achievement were expected to emerge more slowly as teachers and students gain experience with the technology and its affordances for student-centered learning.

Conceptual Framework

To support the transition from theory of change to research design, SRI translated the theory into a conceptual framework that lays out a set of constructs that extensive research has shown to be particularly important to school transformation. These constructs served as a foundation for instrument development across substudies of Apple and ConnectED Research, and are summarized as follows:

- **School context** includes indicators of the social, cultural, and economic environment of the school such as local demographics, school size, the mobility of the student and teacher population, pre-existing educational improvement initiatives, and the accountability climate (Datnow et al., 2006).
- **School improvement processes** include the primary focus areas for the school's overall improvement effort, the goals for improvement in those areas, key factors underlying the improvement goals (e.g., specific features of the school or community context), key milestones, and indicators of progress or success (Harris, 2000; Harris, 2013; Lindahl, 2011).
- **Leadership practices** include the principals' leadership practices (e.g., Leithwood et al., 2004; Waters et al., 2003; Witziers et al., 2003) and the distribution of leadership and responsibilities among positional and informational leaders to promote mutual trust and a shared vision for improvement (Bryk & Schneider, 2003; Kapadia et al., 2007; Spillane, Halverson & Diamon, 2001; Gronn, 2002).
- **Implementation supports for teachers and school leaders** include learning events for school leaders aimed at facilitating the management of school change; professional development (PD) for teachers aimed at improving instruction that adheres to the principles of effective PD (e.g., Desimone, 2009; Garet et al., 2001; Penuel et al., 2005); and a school-based professional community focused on integrating technology to support learning (King & Newmann, 2001; Mortenson, 2011).

When these factors are in place to foster school transformation, the literature suggests several key outcomes that are likely to follow:

- **Changes in teachers' attitudes and dispositions** toward a higher estimation of student capacity (Woolley et al., 2010) and appreciation of technology as a tool for promoting learning (McKnight et al., 2016).
- **Teachers' shifts in pedagogy** to incorporate personalized and innovative learning experiences that provide greater opportunity for students to engage in substantive collaboration and elaborated communication.
- **Improved learning for students** as measured by academic achievement and observed engagement in deeper learning practices that are essential for future workplace success such as substantive collaboration, elaborated communication, creativity, critical thinking, open-ended problem solving, and learning situated in the context of real-world examples and experiences (Zeiser et al., 2014).
- **Shifts in school culture** such as a collective sense of responsibility, an increased sense of agency, and renewed commitment to carry out the work of change (Ingersoll, 2001; Kapadia et al., 2007).
- **Enhanced family and community support** including more culturally and linguistically relevant outreach to families and greater family involvement with schools (Epstein & Sheldon, 2002); more relevant learning experiences that incorporate community resources (Hudicourt-Barnes, 2003); and robust partnerships with community institutions (Shaari & Hung, 2013).

Dimensions of Deeper Learning

Deeper learning, related to the study's conceptual framework, refers to changes to the character of teaching and learning in Apple and ConnectED schools to better support skills (e.g., problem solving and teamwork) that are seen as essential to students' success in the modern workplace. To measure deeper learning opportunities that might be seen in ConnectED classrooms, the research team developed a set of specific dimensions and definitions, as summarized in the list that follows. This conception of deeper learning marries constructs which learning science research has shown to promote strong and lasting learning outcomes, and leading frameworks for deeper learning and 21st century skills (e.g., Bransford et al., 2000; Sawyer, 2014; ISTE, 2016), with the specific types of opportunities that iPad devices and tools are well suited to provide. The latter emphasis was developed through a collaboration between researchers and Apple staff, whose experience with the affordances of iPad in the classroom informed the framing of these dimensions.

- **Critical thinking.** Students address nonroutine problems or explore open-ended questions with no single answer. Stronger lessons make critical thinking the main activity of students' work and promote intellectual independence.

- **Teamwork.** Students work together in pairs or small groups. In the strongest examples, the lesson gives students collective responsibility for a shared learning product they develop together.
- **Communication and creation.** Students create products to express what they know and think. In the strongest examples, they attend to an audience, select appropriate means of expression, and apply principles of design.
- **Real-world engagement.** Students' academic work is framed in the context of the real world outside the classroom. In the most authentic examples, students carry out tasks in the real world in ways that are designed to benefit people or bring about positive change.
- **Use of technology.** Students use technology to deepen or extend opportunities for learning. In the strongest examples, the use of technology transforms the learning opportunity in ways that could not be accomplished without it.
- **Personalization of learning.** The content and pace of students' work varies according to individual needs and interests. Personalization of learning can be accomplished by varying learning tasks to match learning needs, giving students significant choices about their learning, and providing equitable access to content.

The research team also used these dimensions and definitions to develop rubrics that provide a common structure for measuring deeper learning across the various substudies in this research.

The Apple and ConnectED Initiative

The Apple and ConnectED Initiative launched in 2014. Program leaders sought to support schools that serve high-needs students and have the capacity and conditions to benefit from the initiative. To qualify, 96% or higher of the applicant school's students had to be eligible for free or reduced-price lunch. To demonstrate their capacity for growth, applicant schools were asked to provide a detailed description of their plans for the initiative, which were evaluated for strong leadership and vision. Ultimately, 114 schools from across the country, ranging from pre-K to grade 12, were selected to participate in the initiative. These schools are geographically and demographically diverse and serve a wide range of historically underserved communities, including settings such as the inner city, rural towns with high migrant populations, and Native American communities (Table 1).

Table 1. Characteristics of Apple and ConnectED Initiative schools

School Type	Elementary: 72%	Middle: 12%	High: 10%	Other: 6%
Urbanicity	Urban: 43%	Town: 19%	Suburban: 9%	Rural: 29%
Race/Ethnicity (across all schools)	Hispanic: 50%	Black: 33%	White: 11%	Native American: 4%
Economics	Title I eligible: 97%			

Building on decades of classroom experience and the research summarized in the Conceptual Framework section above, Apple designed the ConnectED initiative to give schools the support they would need as they transitioned to fully integrated technology-supported instruction. Along with a substantial donation of technology (an iPad for every student; an iPad and Mac® for every teacher; Apple TV® for every classroom; and Wi-Fi and other infrastructure upgrades across the school), each of the 114 participating schools received a comprehensive set of services through a dedicated team that included:

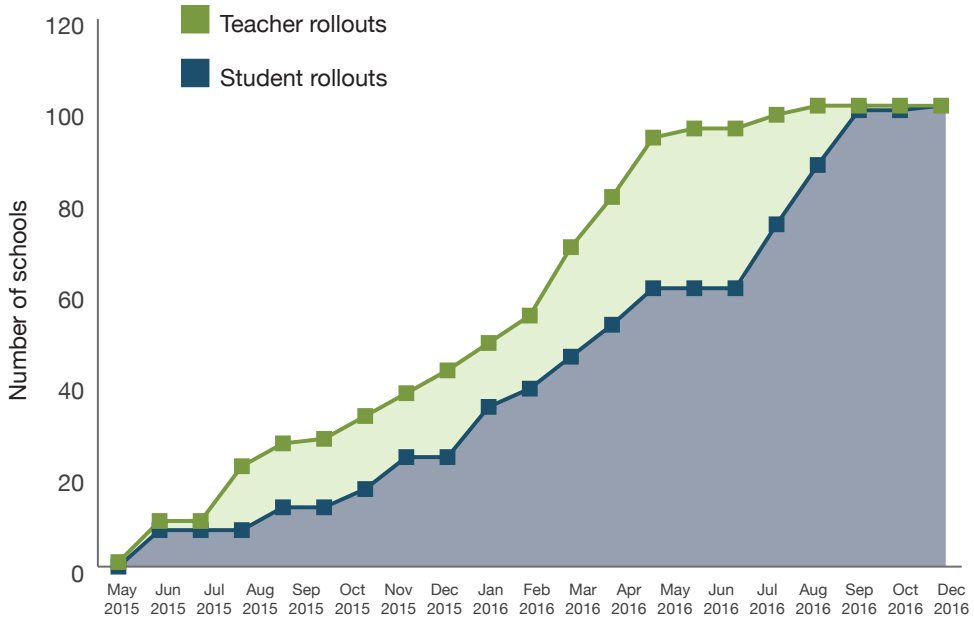
- A member of Apple's team of Development Executives (DEs), who worked closely with school leadership on strategic planning and instructional leadership
- A dedicated Apple Professional Learning (APL) Specialist who provided each school with 17 onsite days of professional learning designed to be responsive to the needs, interests, and capacity of the individual school
- A Project Manager (PM) to manage and guide the process of implementation and coordinate support providers
- A Project Engineer (PE) to provide hardware and software support, as needed

DEs and APL Specialists are education professionals with experience as teachers and/or administrators, which supports their ability to offer individualized coaching to school leaders and teachers. In the Apple and ConnectED Initiative, the APL Specialists engaged teachers in an array of activities that varied according to the needs of the school and typically included instructional coaching around productive technology integration, workshops on educational use of apps and other digital resources, support for lesson design, and guidance for navigating the extensive range of available digital content.

As part of their work with the Apple DE, school-based leadership teams developed strategic plans that included a tailored schedule of iPad device deployment to teachers and students. An important design feature of the initiative was that device rollout at any given school should be based on the readiness of both teachers and technical infrastructure, which resulted in deployment dates that were staggered across participating schools.

This variation in deployment dates was also an important factor in the research. At the time of any particular data collection, teachers and students had spent varied amounts of time with their devices. Figure 1 shows the timeline of ConnectED device rollouts for the 101 schools in the research study[2] between May 2015 and December 2016. Device deployment to teachers occurred before the rollout to students to allow time for teachers to build comfort and plan their instruction. While this timing varied by school, the average length of time between teacher and student deployment dates for schools in the study was 3 months.

Figure 1. Timing of ConnectED teacher and student device rollouts



[2] One district with 13 ConnectED schools did not participate in this research, bringing our full sample for purposes of the study to 101 schools.

Research Design Overview

The research program for the Apple and ConnectED Initiative is a 6-year, independent research study that employs a variety of methods to investigate implementation and outcomes of the initiative across 101 of the 114 participating schools. The scope and duration of the study offered a rare opportunity to paint a comprehensive picture of adoption over time. In the early years of the initiative, from spring 2015 to spring 2017, research focused on initial rollout; the impact of supports provided by Apple; the choices made by schools and educators about their own goals and designs; the varied classroom learning environments that took shape; and the emerging outcomes for students, teachers, and schools. 2017-18 and 2018-19 provided opportunities to look at factors that shape sustainability of technology-infused learning initiatives over time. Throughout, the research was designed to capture the variety of rich and challenged contexts in which the Apple and ConnectED schools are situated.

Research Questions

The goals of the study are summarized in six overarching research questions, listed below. The first five motivated the initial study designs. Research question 6 was added to shape design revisions as implementations at the schools matured with two or more years of experience and the initial intensive programmatic support from Apple gave way to periodic interactions with the schools.

1. **Academic outcomes:** What academic outcomes result from the implementation of the Apple and ConnectED Initiative in diverse, under-resourced community settings?

2. **Additional outcomes:** What additional outcomes for students (e.g., deeper learning, engagement) and educators (e.g., commitment to the profession) do participants achieve?

3. **Learning environment and pedagogy:** How do learning environments and pedagogy change in participating classrooms?

4. **Out-of-school connections:** How does the initiative connect students' lives and learning inside and outside of school?

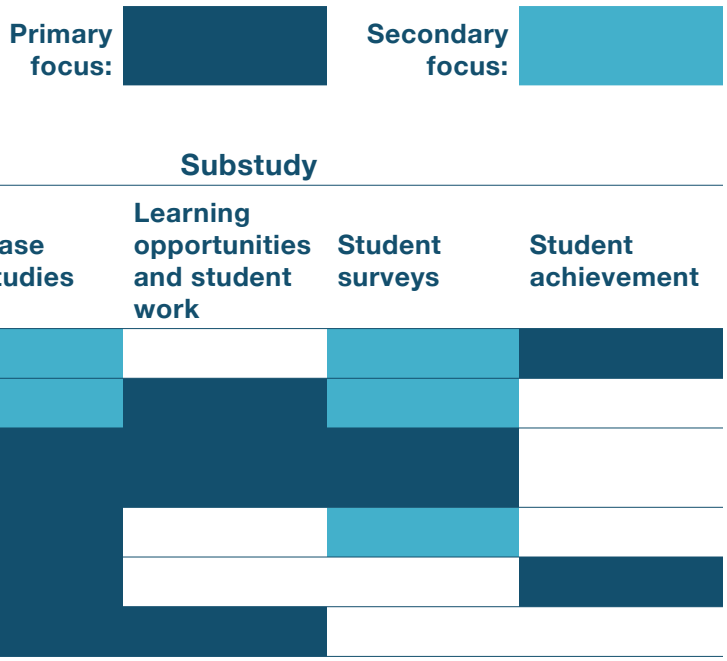
5. **Implementation models:** What innovative models for effective 1:1 technology implementation emerge from the initiative in historically underserved settings? What implementation factors (e.g., school leadership, professional development) appear to correlate with success?

6. **Sustainability:** What factors contribute to the sustainability of the initiative over time?

Substudies

To address the research questions, Apple and ConnectED Research is organized into five integrated substudies that offer both breadth and depth of data: (1) school leader and teacher surveys; (2) case studies; (3) learning opportunities and student work (LOSW); (4) student surveys; and (5) a student achievement study. Each substudy is grounded in the common framework described earlier and provides a different perspective on the initiative and its implementation and outcomes. Figure 2 maps each substudy to the overarching research question(s) it was designed to inform.

Figure 2. Mapping of substudies to the overarching research questions



The substudies and data collection timeline (Figure 3) are summarized below.

1. **School leader and teacher surveys** were designed to collect common data about implementation and outcomes across the entire initiative over time. The school leader survey was administered annually for four years to one senior administrator in each ConnectED school participating in the research study. The teacher survey was administered for three years to all teachers in the same set of schools.

2. **Case studies** included site visits to a smaller number of participating schools, with the goal of gaining a deeper look at teaching, learning, and program implementation in ConnectED schools and communities. Case study schools were selected based on factors such as diversity of geography, grade levels, and populations served. A total of 15 schools were visited across two

waves of data collection to examine initial implementation in spring 2016 to fall 2017 and to understand ongoing progress in spring 2018 to spring 2019.

3. **Learning Opportunities and Student Work (LOSW)** comprised the rubric-based analysis of teacher-submitted lesson materials and related student work to investigate the incidence and character of deeper learning opportunities in ConnectED classrooms. Lesson samples were solicited over a two-year period from six teachers in each of 11 of the case study schools. In the final year of data collection, the deeper learning rubrics were applied to data from classroom observations that took place as part of case studies.

4. **Student surveys** captured students' voices about their ConnectED experiences. Student surveys were conducted annually for three years beginning in school year 2016-17. They were administered to all students in select grades in 11 of the case study schools and four additional schools selected to increase representation of middle and high schools.

5. **A student achievement study** examined student learning outcomes in grades 3, 4, and 5 across the timeframe of the Apple and ConnectED Initiative. Based on publicly available grade-level aggregate scores on state exams from 2015 to 2019, the study compared academic achievement gains between 42 ConnectED schools in 23 districts in 13 states with matched nonparticipating school comparisons from the same district. In addition, SRI collected student-level achievement data for seven ConnectED schools in four districts from school years 2015-16 to 2017-18, to look at possible predictors of achievement gains based on teaching practices and other variables reported on the teacher survey.

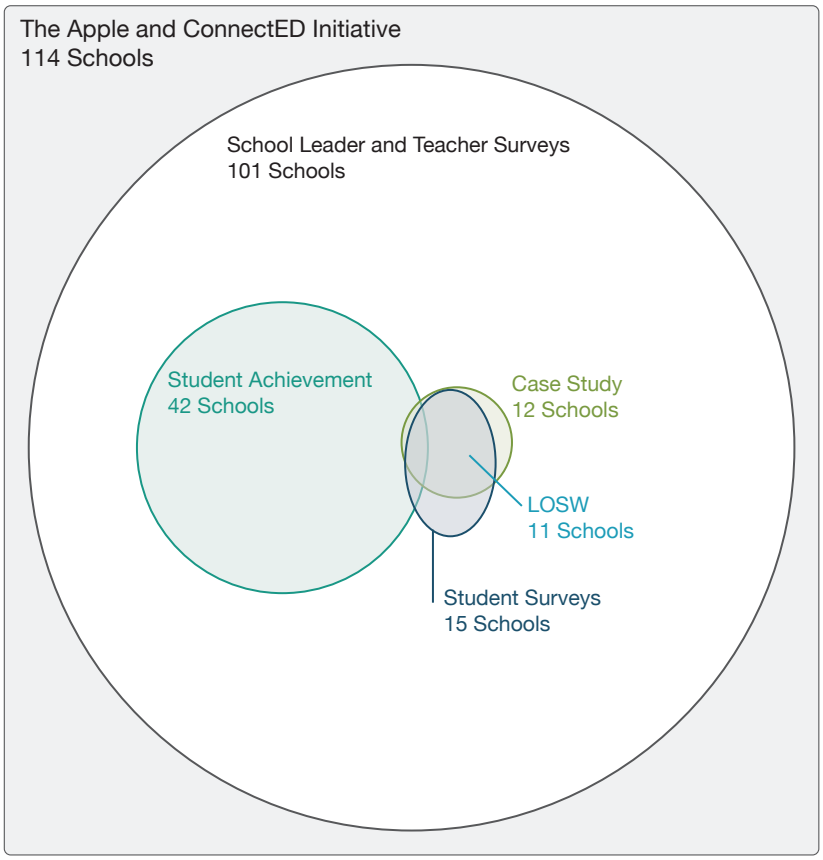
Figure 3. Timeline of Apple and ConnectED Research data collections

	2015			2016				2017				2018				2019			
	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec
School Leader and Teacher Surveys	●		●						● ●				● ●				●		
Case Studies					●		●	●	●		●	●	●		●	●	●		
Learning Opportunities and Student Work (LOSW)					●		●	●	●			●	●		●	●	●		
Student Surveys								●				●				●			
Student Achievement	●				●				●				●				●		

Substudy Samples and Focal Grades

Apple and ConnectED Research included 101 schools. As shown in Figure 4, the five substudies were designed to include overlapping samples of schools. This approach allowed us to collect quantitative data across a larger number of schools to enable a broad set of analyses across the program while also collecting more nuanced, in-depth qualitative data from a diverse subset of schools. To further target our sample, with the exception of teacher surveys that included all instructional staff within a school, data collections focused on particular grade bands. The target grade bands included grades 4-5 in elementary schools, 7-8 in middle schools, and 10-11 in high schools, with multiple grade bands represented as appropriate in K-12 schools or other schools that served a wider range of ages.

Figure 4. Overlap in school samples for Apple and ConnectED Research substudies



Note: One district with 13 ConnectED schools did not participate in the research on this program. Additionally, as described throughout this report, some replacement of schools in the various samples occurred over time; this figure depicts the original samples.

Participation Incentives

In most cases, due to the project sponsor's relationships with states, the research study could not offer individual incentives to teachers who gave their time for interviews or other data collections. Where possible, we offered something for a group of teachers, by providing schools with funds for pizza or ice cream during the time set aside to complete surveys or submit lesson samples, or by offering schools a gift card if all participating teachers submitted their materials by the deadline. School level reports of teacher survey results were shared with schools with over 70% response rate. Each school also received a descriptive report that included responses from all surveyed teachers (i.e., including teachers from all participating ConnectED schools) to facilitate comparisons with their own schools' responses. We are grateful to the many teachers who donated their time to participate in the study.

Substudy Descriptions

This section describes each of the five substudies that comprise the Apple and ConnectED Research study in terms of their purpose, sample, instruments, data collection, and analytic approach.

School Leader and Teacher Surveys

The school leader and teacher surveys were designed to provide longitudinal quantitative data from all ConnectED schools to enable a broad set of analyses across the whole program and for a variety of subgroups of schools and teachers. The surveys aimed to characterize learning environments and pedagogy and help describe schoolwide and classroom implementation models. Survey data were used to identify factors that seem to correlate with successful pedagogical change, perceptional change, and deeper learning, and were used as covariates in the student outcomes analyses.

Key research questions for the school leader and teacher surveys included:

- What outcomes for students and teachers do participating educators report?
- How and to what extent are teachers using technology in their instruction?
- How do school leader and teacher reports of learning environments and pedagogy change over time?
- How is professional learning provided by the initiative similar to and different from other professional learning that teachers typically experience?
- What implementation factors appear to correlate with success?
- What factors contribute to the sustainability of the initiative over time?

To answer these questions, the teacher survey asked about a wide range of topics, including teachers' pedagogical beliefs, instructional practices, use of technology in the classroom, professional learning experiences (ConnectED and non-ConnectED), and the school's organizational culture. The school leader survey asked about school leadership and organizational culture, school improvement goals and priorities, ConnectED implementation, schoolwide pedagogical beliefs and practices, and professional learning for teachers and leaders. In later years, both surveys asked for reflections on program sustainability.

Sample

The teacher surveys were collected in three waves (fall 2015 and spring of 2017 and 2018); the school leader surveys were collected in four waves (spring 2015, 2017, 2018, and 2019). School leaders and teachers from the 101 schools participating in the research were invited to take the surveys. The teacher survey sample included all teachers and other school staff with instructional roles (e.g., instructional coaches, technology coordinators, librarians) who received a device from Apple.

Instruments

Apple's theory of change, a literature review on instructional reform initiatives involving educational technology, and conversations with Apple about their priorities for the initiative helped the team identify the topics to include in the surveys. ConnectED survey items included a mix of items, sometimes modified, from existing survey instruments (especially on topics related to 1:1 implementation, teacher attitudes toward technology, and questions around the nature of technology integration for teaching and learning) for which permissions were obtained, and additional items developed by the research team to cover the full range of topics.[3]

Surveys were designed and programmed for online administration. Both surveys were designed to take a maximum of 45 minutes to complete. The survey platform allowed respondents to save their progress and complete it over multiple sittings, if needed. Although incentives were not allowed for individual teachers, beginning in the second administration each school was offered $50 to support the purchase of refreshments for teachers while taking the survey.

Development of the school leader and teacher surveys included reviews from experts in the field external to SRI, cognitive interviews with five principals and five teachers, and pilot testing with 132 teachers who served similarly under-resourced communities to see whether the instruments functioned as intended. We examined descriptive statistics and the internal consistency of scales (coefficient alpha) from the pilot study and revised or discarded items that functioned inconsistently with the others in the set. Fifteen scales were created from fourteen different sets of items in the pilot study. Each set of items was on a four- or five-point Likert scale. Exploratory analysis confirmed the levels could be treated as evenly spaced (i.e., as an interval scale). The coefficient alpha of most scales ranged from .70 to .90.[4] The pilot resulted in some clarification of language and response choices, but no major revisions to content.

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[3] Items were either used with permission or adapted from the USE IT principal survey (Abrams & Russell, 2004); USE IT teacher survey (Russell, Bebell, & O'Dwyer, 2003); CCSR teacher survey (CCSR, 1999); CCSR principal survey (Sebastian & Allensworth, 2012); Digital Promise teacher survey (Dwyer, 2014); and Project Red survey (Greaves et al., 2010).

[4] The exceptions were two scales related to teachers' knowledge of students' lives, which had alphas of .61 and .63 and were ultimately de-emphasized in analysis.

For each new survey administration, we updated the survey instruments to reflect evolving priorities of the initiative and the research. For example, questions about current support offerings and initiative components were kept up to date, and an emphasis on sustainability was added in later years. Portions of the teacher survey instrument are available at https://connected-research.sri.com/.

Data Collection

The baseline school leader survey was administered online in spring (April – June) 2015, prior to device rollout in most ConnectED schools, with subsequent administrations in spring 2017, 2018, and 2019. In each case, a link to the online survey was emailed to each participating principal. In a few cases, the survey was completed by an assistant principal or other school administrator.

The baseline teacher survey[5] was conducted in fall/winter 2015-16 (October 2015 – January 2016) with subsequent surveys in spring of 2017 and 2018. Surveys were emailed to all instructional staff based on rosters solicited from the school before the survey administration. To reach the research team's target of a 75% response rate per school, each school had a designated research team member who corresponded with the school principal or principal's designee to provide email updates about the survey timeline, a roster check that included individual survey completion status and email addresses approximately one week after survey launch, and support in updating the roster as needed. Principals received weekly email updates of their school response rates. In the final weeks of the survey, research team members sent individual email reminders to teachers who had not yet completed the survey. Table 2 provides sample sizes and response rates for the surveys for each administration.

[5] By the time of initial teacher survey administration, some of the schools had already received their devices, so questions about teaching practices could not be considered a true baseline. As such, questions in the fall 2015 teacher survey describing classroom activities or use of technology were phrased to refer back to the previous spring.

Table 2. Sample sizes and response rates for school leader and teacher surveys

Activity		Term				
		S15	F15	S17	S18	S19
School Leader Survey	Schools Sampled	101	-	100	99	94
	School Leaders Sampled	101	-	100	99	94
	School Leaders Responding	97	-	83	73	71
	Participation Rate	96%	-	83%	74%	76%
Teacher Survey	Schools Sampled	-	102	101	99	-
	Schools Participating	-	102	101	99	-
	Teachers Sampled	-	3222	3172	3037	-
	Teachers Responding	-	2610	2432	2044	-
	Participation Rate	-	81%	77%	67%	-

Note: The decline in "schools sampled" from year to year was due to schools that closed, merged, or opted out of the research.

Analysis

Data were initially cleaned to eliminate data from respondents who did not provide consent, indicated they taught less than 25% of the time at the ConnectED school to which the survey was administered, and/or did not complete the first substantive section of the survey. We used study IDs to merge cleaned data from multiple survey administrations and link individuals' responses over time. We also created scale scores and transformed data (e.g., dummy-coding, collapsing responses into larger and more descriptive categories, converting Likert scales to numeric) in ways that enabled further analysis.

For each round, we examined descriptive statistics (response counts, distributions, and central tendencies) and internal consistency of scales. We descriptively examined similarities and differences in response patterns across participant subgroups, especially across teachers' subject area, age group taught, and levels of technology adoption. We also examined relationships between items or scales including those (1) within the teacher survey, (2) within the school leader survey, (3) across school leader and teacher surveys, and (4) within/across surveys across time.

For changes over time, we examined both cross-sectional and overlapped samples for those respondents participating in multiple survey administrations. Cross-sectional data analysis compared participants across years based on current samples in each year, while overlap analyses compared only the participants who had responded to the survey across the years included in the comparison.

Regression analysis and hierarchical linear modeling (HLM) were used to identify predictors of key outcomes such as deeper learning opportunities and sustainability. Teacher survey analysis used HLM to account for the nesting of teachers within schools; multiple regression was used to analyze the school leader survey. The analyses were conducted on individual years and across years for the school leader and teacher surveys. P-values and effect sizes were consulted to determine statistical and practical significance of the results.

Case Studies

Case studies offer a nuanced picture of the Apple and ConnectED Initiative in a diverse subset of 15 participating schools. Case study research described (1) the implementation of ConnectED, situating it in the broader context of the school's vision for transformation; (2) teaching and learning practices, and the extent to which ConnectED resources support teachers in enacting student-centered instruction; and (3) how ConnectED is being sustained. Case studies also attended to the extent and nature of the school's involvement with families and the local community in the context of ConnectED.

The research questions addressed by the school case studies include:

- What was teachers' experience of Apple Professional Learning?
- What implementation factors appear to correlate with success?
- How did learning environments and pedagogy change in participating classrooms?
- How did ConnectED impact the local community?
- What learning outcomes did staff and students report?
- How can ConnectED be sustained over time?

The case studies also highlighted similarities and differences across schools with respect to their use of the ConnectED resources and how ConnectED advanced the schools' goals for improvement. By identifying and describing the experiences of schools, teachers, students, and families/communities in a subset of ConnectED schools, the case study research provided concrete, practical knowledge about ConnectED that demonstrated what is possible in under-resourced schools and revealed the processes through which positive transformations were achieved.

Sample

The case studies included two waves of data collection to examine initial implementation in spring 2016 to fall 2017 (wave 1) and to understand ongoing progress in fall 2018 to spring 2019 (wave 2). In selecting specific schools for case studies, the research team sought variation on a number of dimensions, including school type (elementary, middle, and high schools), student population demographics, school size, urbanicity, and leadership capacity as measured on the principal survey. Twelve schools were selected and visited for wave 1. In wave 2, six of the original case study schools received a second visit and the remaining six original schools either declined to participate in a second visit or had closed or reorganized. Three additional schools were recruited to fill those vacancies. A total of 15 schools were visited across the two waves, the characteristics of which are summarized in Table 3.

Table 3. Characteristics of case study school sample

School Type*	Locale	2015 Enrollment	ConnectED Start Date	Population Served**	Wave 1/Wave 2
Combined	Rural	80	Spring 2015	Native American	Wave 1; withdrawn
High	Urban	120	Spring 2016	Black	Wave 1; Wave 2
Early Childhood	Urban	180	Fall 2015	Black	Wave 1; Wave 2
Elementary	Rural	188	Spring 2016	Hispanic	Wave 2
Elementary	Rural	248	Spring 2016	Black	Wave 1; withdrawn
Elementary	Urban	350	Fall 2015	Hispanic	Wave 1; Wave 2
Elementary	Town	350	Fall 2015	Black	Wave 1; Wave 2
Middle	Rural	367	Spring 2016	White	Wave 1; Wave 2
Elementary	Urban	388	Spring 2016	Hispanic, Black	Wave 1; withdrawn
Combined	Rural	397	Spring 2016	Native American	Wave 1; Wave 2
Early Childhood	Urban	550	Spring 2015	Hispanic	Wave 2
Elementary	Suburban	587	Fall 2015	Hispanic	Wave 2
Elementary	Rural	600	Fall 2016	Hispanic	Wave 1; withdrawn
Middle	Urban	753	Spring 2015	Hispanic	Wave 1; Wave 2
High	Suburban	1373	Fall 2015	Black	Wave 1; withdrawn

**The high proportion of elementary schools reflects the greater number of elementary schools served by the Apple and ConnectED Initiative.*

***Population is listed if it included at least 30% of the student body.*

Within case study schools, five to six teachers were chosen who worked with the focal grades (4, 5, 7, 8, 10, 11) and who covered a range of core subjects, such as mathematics, literacy, and science. Principals were also asked to select teachers at different levels of experience with technology in the classroom.

Instruments

Case study instruments included an observation protocol and semi-structured protocols for interviews and focus groups. The observation protocols gathered information about teachers' instructional practices, particularly their use of the ConnectED resources and technology-enabled opportunities for deeper learning. The protocol addressed learning goals, how and why ConnectED resources were used, the teaching and learning interactions taking place around technology resources, and student engagement.

Principal and teacher interviews asked about experiences with ConnectED, instructional practices and challenges, professional development experiences, support needed, and efforts to connect with families and communities. Principal interviews addressed their leadership practices and plans for school improvement. The student focus groups gathered input on ConnectED resources, perceived benefits of the program, and the challenges they encountered; parent questions explored the school-family connection. Questions for Apple personnel focused on their history with the school, their impressions of the school context, how they were supporting the school's goals, challenges and successes, and prognosis for sustainability. As opportunities arose, the research team interviewed other stakeholders, such as district personnel and community members. The district interviews used a modified principal protocol, and the community member interviews used a modified parent protocol.

Data Collection

After site-visit training for the case study team, two researchers conducted each visit. To the extent possible, wave 2 visits were staffed with the same researchers who visited the school in wave 1. Table 4 lists the total number of classroom observations, principal interviews, teacher interviews, student and parent focus groups, and other staff interviewed over the course of the initiative for the case studies. The research team also interviewed seven Apple and ConnectED field staff.

Table 4. Case study data collection summary

Data Type	SY 2015-16	SY 2016-17	SY 2017-18	SY 2018-19	Total
Classroom observations	20	35	12	47	114
Principal interviews	3	7	2	9	21
Teacher interviews	19	36	12	48	115
Student focus groups*	4	7	3	9	23
Parent focus groups**	2	5	2	7	16
Family/community liaisons or instructional/IT tech support personnel	2	9	4	8	23

**Each student focus group contained 6 to 8 students.*
***Each parent focus group contained 1 to 6 parents.*

In spring and summer 2019, the research team conducted an additional 11 interviews with four principals, two instructional coaches, and five teachers in four schools that were not part of the case study group. The schools were chosen because they scored high on measures of sustainability in the 2018 teacher and principal surveys. The sustainability interviews were focused on how the schools were continuing ConnectED after the intensive phases of support from Apple had concluded.

All interview and focus group recordings were professionally transcribed in preparation for analysis. Observational data were organized into a summary table.

Analysis

Our general approach to analysis was to begin at the school level and then to employ a comparative case analysis (Yin, 2013) to discern themes across the schools. The case study team coded the interview and classroom observation data for key themes across constructs. These themes were determined both a priori and inductively, and included student outcomes, teacher professional learning and supports, principal and school leader supports, initiative sustainability, and community engagement. Generally, members of the research team were assigned to code all data from a particular school and served as the expert for that case. Post-coding analysis focused on summarizing key points within each theme across schools.

To produce a summary for each school, site visitors first debriefed their visit using a key take-aways template that focused on syntheses of data about the school, community, use of iPad devices, and aspects of teaching and learning. Where appropriate, the site experts (1) inserted relevant data from

interviews and observations to substantiate and refine claims and (2) removed or modified claims that were no longer relevant or accurate based on findings that emerged from interview coding. An additional team member familiar with the school data reviewed the document for reliability, and the team members resolved any discrepancies. The case study team also conducted debrief meetings to synthesize themes across schools.

Learning Opportunities and Student Work

The learning opportunities and student work (LOSW) substudy uses samples of lessons, related student work, and classroom observations to examine how teachers in the Apple and ConnectED Initiative incorporated deeper learning opportunities into classroom instruction. Deeper learning opportunities build students' skills through teamwork, critical thinking, and communication and creation; personalize learning and engage students in solving real-world problems; and employ technology to support and enhance learning objectives.

Primary research questions guiding the LOSW study include:

- To what extent are teachers using iPad devices to provide students with deeper learning opportunities? What is the character of these opportunities?
- To what extent, and in what ways, are students engaging in deeper learning?
- In what ways does the presence and depth of deeper learning opportunities evolve over the course of the initiative?
- How are schools planning to deepen learning opportunities beyond the initiative?

Sample

The LOSW study was conducted with six teachers at each of ten case-study schools. The selected teachers were typically those who participated in classroom observations and interviews during case studies. They were sampled according to grade level, subjects taught, and experience using technology.

For each collection, teachers chose a focus class and were asked to submit three learning opportunities (lessons) over the course of a semester or year, each with six corresponding pieces of student work from a random sample of students. Teachers were asked to submit what they judged to be their strongest learning opportunities.

The final LOSW analytic sample for data collected from spring 2016 through spring 2018 included 68 teachers and 198 LOSW packages across ten case-study schools (Table 5). The sample of classroom observations included 29 lessons across seven case-study schools and ranged from two to seven observations per school.

Table 5. LOSW substudy submissions and timeline

Activity		Term				
		S16	F16	S17	F17/S18	F18/S19
Learning Opportunities (LO) and Student Work (SW)	Schools Sampled	11	10	10	10	10
	Schools Participating	4	5	7	5	-
	Teachers Participating	21	16	22	14	-
	LO Submissions	57	40	69	43	-
	SW Submissions	252	300	439	230	-
Classroom Observations	Schools Participating	-	-	-	-	7
	Teachers Participating	-	-	-	-	31

Instruments

The six deeper-learning dimensions and definitions described in the Conceptual Framework section drove instrumentation for the LOSW study. To operationalize these definitions, the team created a learning opportunity (LO) rubric for each dimension. A corresponding student work (SW) rubric was created for communication and creation, critical thinking, real-world engagement, and use of technology.[6]

The rubrics specify a four-point scale from not present to highly present to measure the strength of the opportunity for each dimension as represented in the lesson and the degree to which the related skill was demonstrated in the student work. Each rubric is supported by detailed definitions for each level of the scale to clarify what each dimension looks like in practice and how basic instantiations of the dimension differ from more sophisticated and powerful examples of each type of learning opportunity.

Cover sheets for learning opportunity and student work submissions were developed to capture consistent data across submissions that could be used in coding. The cover sheets included questions about the learning objectives; duration of the lesson; a description of what the students created; and students' special education status, English learner status, and grade level.

[6] Student work rubrics for teamwork and personalized learning were intentionally not created because evidence to support these dimensions are typically not apparent in a student work sample. For teamwork, for example, the student work sample would be a final product such as a presentation, video, or report. This final product would not provide information about how the group worked together during the process of its creation.

Data collection

From 2016-2018, the LOSW study relied on data collection of learning opportunity and student work (LOSW) materials and classroom observations. In 2018-2019, the LOSW study began using classroom observation data that was collected during case-study site visits.

Learning opportunities and student work (2016-2018). Each teacher submitted three LOSW packages consisting of one lesson and six corresponding pieces of student work during every academic semester from spring 2016 through spring 2017. Because of the demands on teachers' time, for 2017-18, the research team requested one submission of four LOSW packages that represented the entire academic year.

For each lesson, teachers submitted a lesson plan and other instructional materials such as grading rubrics, a coversheet with questions about the lesson's context, and background information about the student work samples. Student work included completed assignments.

Teachers could submit LOSW materials through an online secure SRI platform or by mailing materials to the research team.[7] Teachers submitting materials through SRI's online platform had a unique workspace for each LOSW submission and received unique links to an online coversheet, exit tickets, and submission folder. The research team developed a consistent file naming convention for all electronic files and asked teachers to remove students' names from submissions. Researchers offered videoconferences to help walk teachers through the online submission process. Teachers who preferred to mail materials to the research team received prepaid FedEx envelopes.

Classroom observations (2018-19). Because the time associated with collecting LOSW package materials and submitting the materials was a central barrier for collecting complete LOSW packages, in 2018-19, the research team incorporated deeper-learning data collection into classroom observations that were occurring as part of the case studies. Case-study site visitors participated in a training on the LOSW dimensions and used a classroom observation protocol that was aligned to the LOSW framework.

[7] In 2018, platform constraints required that teachers wishing to submit files larger than 100 MB (e.g., iMovie, iBook, GarageBand) submit them on a flash drive. Teachers submitting flash drives received a flash drive and pre-paid FedEx envelope from the research team.

Analysis

The research team analyzed LOSW submissions separately from classroom observations.

Analysis of LOSW submissions. The final analytic sample excluded learning opportunities or student work samples that were collected but unusable because they were illegible or lacked sufficient detail. In some cases, certain parts of LOSW packages were included in the analysis when they provided sufficient information about one or more deeper learning dimensions.

A team of researchers coded each learning opportunity and student work sample using the project's deeper learning rubrics. Before coding submissions, the research team participated in a training that introduced the rubrics and their application. They coded several examples for each dimension as a group. Individual researchers then coded one or two additional examples independently and discussed areas of disagreement to further build a shared understanding of the dimension's definition and rating scale.

Group coding sessions were held after each data collection cycle (spring 2016, fall 2016, spring 2017, spring 2018), with some subsequent independent coding. The research team double coded approximately 10% of the sample to ensure interrater reliability. For the majority of learning opportunity dimensions, perfect agreement ranged from 75% to 85% of the ratings.

After the research team coded the LOSW submissions, an analyst calculated the percentage of learning opportunities and student work submissions coded on each step of the rubric scale (Not Present, Low, Medium, and High). In addition, the analyst examined correlations between dimensions using Spearman's rank correlation to see if learning opportunities that provided depth in one dimension also provided depth in others.

Spring 2016 data were considered "baseline" with the exception of one school,[8] as that timeframe was generally prior to device deployment in the participating schools. Analysis of submissions collected from fall 2016 to spring 2018 provide examples of the types and depth of deeper learning opportunities teachers offered to students during the Apple and ConnectED Initiative and can offer some emerging themes, but the samples cannot be considered representative or support broad statements about the progress of deeper learning over the course of the initiative.

Analysis of classroom observations. After each observation, the observer rated the lesson according to each dimension's rubric, providing evidence to justify each rating. An analyst with expertise in the deeper learning rubrics reviewed the classroom observation data and also rated each lesson.

[8] One school in the spring 2016 data collection was already using ConnectED devices, so that data collection includes limited evidence of "baseline" teaching practices.

An important difference between classroom observations and LOSW submissions is the scope of data for each teacher. During site visits, only one class was observed per teacher. In contrast, data from LOSW submissions were submitted for several lessons per year, with some of the lessons—particularly those that were stronger examples of deeper learning—extending across multiple class periods. As a result, data from the two methods were not sufficiently comparable for analysis. Instead, data from classroom observations were used descriptively within the context of other information related to deeper learning at the school.

Student Surveys

The student survey was created to better understand students' experiences with ConnectED, and to represent these experiences in students' own voices. In addition, the student survey aimed to explore students' non-academic outcomes and how they may vary across school settings and student populations.

Key research questions for the student survey included:

- What are student perceptions of the program? How do they differ between sites, intervention types, and subgroups?
- What non-academic outcomes might ConnectED help students achieve?
- How does ConnectED connect students' lives and learning inside and outside of school?

To answer these questions, the survey asked about students' engagement in learning in school, use of iPad devices in school, perceived usefulness of iPad devices for learning, use and perceived usefulness of iPad devices outside school, access to technology at home, and plans for college and career.

Sample

The survey was designed to be cross-sectional, targeting the study's focal grades (4, 5, 7, 8, 10, and 11) annually for three years. To capture a large variation in student perspectives and to support the case-study data collection, we sampled students in the target grades in 11 of the 12 original case study schools,[9] which had been selected for their diversity of implementation contexts. Because the case-study sample, like the overall Apple and ConnectED Initiative, was heavily weighted toward elementary schools, four additional middle and high schools were recruited to participate in the surveys to increase the representation of schools and students at those grade levels. The

[9] The student survey was not administered in one early childhood school in the case study sample, which did not include students as old as grade 4.

surveys were administered using the iPad, with the first round administered only after students had acclimated to using the devices.[10] Thus, the first survey captures student perspectives earlier in their use of the iPad rather than perspectives when they did not have an iPad.

Table 6 includes the number of schools and students sampled and the participation rates. Changes in the number of participating schools over the years correspond to changes in the case-study school sample.

Table 6. Sample sizes and response rates for student surveys

Activity		Term		
		S17	S18	S19
Grade 4-5	Schools Sampled	7	6	5
	Students Sampled	924	579	500
	Students Participating	859	462	369
	Participation Rate	93%	80%	74%
Grade 7-8	Schools Sampled	3	5	5
	Students Sampled	1043	1094	1034
	Students Participating	515	861	701
	Participation Rate	50%*	79%	68%
Grade 10-11	Schools Sampled	4	6	4
	Students Sampled	590	741	267
	Students Participating	454	451	150
	Participation Rate	78%	61%	56%
Total	Schools Sampled	13	11	10
	Students Sampled	2557	2414	1801
	Students Participating	1828	1774	1220
	Participation Rate (total students sampled / participating)	71%	73%	68%
	Participation Rate (school average)**	84%	73%	70%

**One of the participating middle schools, which had the largest sample size, required parental consent, and therefore had a low response rate, skewing the overall response rate.*

***We include the school average because the total number of schools was small and the participation rate across schools varied greatly in some cases.*

[10] Nine schools were in their first year of use, while four schools were in their second year of use.

Instruments

A pilot version of the survey was designed based on a review of the literature, consultation with experts on social-emotional learning, and many iterations among a three-person research team. The pilot version of the survey consisted of 32 mostly closed-ended questions and a few short-answer items. The survey was designed to be administered on the iPad by the teacher, where students would log in using anonymous survey IDs so their progress would be saved if they accidentally logged out. We aimed for the language to be accessible even to the youngest of the survey takers (grade 4 students). We also avoided including skip logic until at least two-thirds of the way into the survey so that elementary teachers could conduct it as a paced whole-class activity if they thought it necessary.

One researcher guided two grade 4 students in a cognitive lab, where they were encouraged to think out loud and to raise questions, and were questioned for their understanding of the questions while they took the pilot survey. For the most part, their responses indicated that the questions' language, format, and length were appropriate, and that students would be able to interpret the questions in the way they were intended.

The pilot survey was piloted by 59 grade 5, 65 grade 8 and 89 grade 10 students who attended ConnectED schools that were outside the student survey sample. At the end of the survey, students were asked five questions about the ease and accessibility of the survey. The three teachers who administered the survey were also asked to provide feedback about the administration protocol and process and clarify two unexpected student response patterns. Students received a small gift (an eraser or pen) for their participation, and teachers received a summary of their students' responses.

The pilot survey provided further evidence that the items and process were easily understood by students, and the survey was the appropriate length. Students' responses painted a coherent picture of how iPad devices were used and what students thought of their use. Their responses aligned well with teacher reports about how students had been using the devices.

The final version of the survey for the 2016-17 administration consisted of 31 questions. It was translated into Spanish and programmed so that students could switch back and forth between the two languages at any point of the survey. Most survey questions about in-school use of iPad devices remained consistent across the subsequent two administrations to allow for comparison across years. We reduced the number of questions about iPad home-use in years 2 and 3, because very few students were taking the iPad home. In years 2 and 3, we added a few questions that asked students to elaborate on examples of impactful uses (if any) of the devices, and in the third administration, school leaders were given the option to add a question of their choice.

Data Collection

The survey was administered annually to all grade 4, 5, 7, 8, 10, and 11 students in the sample schools from winter to early spring of school years 2016-17, 2017-18 and 2018-19. The survey IDs were confidential for the first year of the survey and associated with student names and/or IDs based on rosters provided from the school. We obtained active parental consent from two schools, per district requirements. Starting the second year, however, we used anonymous surveys because it was not necessary to link any of the datasets with external student-level information. Based on this change, none of the schools required active parental consent for the second and third administrations.

School leaders selected the specific time frame and classes (e.g., homeroom) in which survey administration took place at their school, and teachers administered the survey. Teachers were mailed physical login cards with survey IDs for their students and an administration protocol; students took the survey on their iPad devices. The administration protocol and the assent page encouraged students to provide honest feedback and indicated that their participation was voluntary.

Students generally finished within 20 minutes. The survey participation rate by school averaged between 70% and 83% per administration (Table 6). School-level reports (with results reported separately for each grade band) were shared with each of the participating schools.

Analysis

For each round of surveys, we examined descriptive statistics (response counts, distributions, and central tendencies) and the relationships between student responses to different questions. We also examined differences and similarities in responses across items, grade bands (elementary, middle, and high), and schools. Starting the second year, we examined patterns across time in the overall sample, grade bands, and schools. Individual survey responses were not linked across administrations, so it was not possible to track student-level change over time.

Open-ended responses on students' favorite learning activities using the iPad and what students do not like about using an iPad for learning were coded into categories that were held constant across time. Open-ended responses on how students thought learning with their iPad changed their perceptions or learning were examined for common responses and for informative responses across students and age groups.

Student Achievement Study

The student achievement study aimed to answer the following two questions:

- What academic outcomes result from the implementation of the Apple and ConnectED Initiative in elementary schools?
- What ConnectED-facilitated experiences and instructional practices are related to student academic outcomes?

The first research question aimed to estimate the overall impact of the Apple and ConnectED Initiative on academic outcomes as measured by policy-relevant state assessments. The research looks at performance trends for ConnectED schools in comparison to the expected trends for students in comparable, but nonparticipating, schools in the same districts given their prior achievement results and other relevant characteristics. This analysis provided evidence on whether the schools participating in the Apple and ConnectED Initiative exhibited higher reading or mathematics performance compared to similar schools in the same districts.

The second research question asked how academic achievement outcomes varied as a function of classroom practices and experiences within the Apple and ConnectED Initiative, focused on markers of teaching, learning, and teacher and student experiences with the initiative, all based on measures in the teacher survey. This correlational analysis provided evidence of relationships between specific ConnectED-facilitated classroom practices and/or experiences to student academic achievement.

Impact Study Sample

We were able to collect publicly available, school-level achievement data from 23 districts with 42 ConnectED elementary schools in 13 states from state Department of Education websites. All these districts have nonparticipating elementary schools that are similar to the ConnectED schools in terms of student achievement and demographics, and most of them used consistent assessments (mostly Common Core) for the duration of the program. We also obtained school demographic characteristics for schools in these districts from the Common Core of Data from the Department of Education. We applied propensity score matching to match each of the 42 ConnectED schools with all other elementary schools in the same district that were within 0.5 standard deviation of the ConnectED school's propensity score. The propensity score was estimated from school characteristics such as % White students, % free and reduced-price lunch (FRPL) students, and English Language Arts (ELA) and math performances before the initiative started. Among 329 comparison schools in these districts, we identified 180 schools that were similar in prior achievement and other school characteristics to the ConnectED schools (Table 7).

Table 7. School sample for student achievement impact study

	ConnectED	Comparison
Elementary schools in the 23 districts	42	329
Matched schools included in the analysis	42	180

Impact Study Data Collection

We collected student achievement data in ELA and math from spring 2015 to spring 2019 for all the achievement substudy schools. Because only a fraction of states report average student test scores on state standardized assessments, we used percent proficient/meeting standards at grade 3, grade 4, and grade 5 as performance indicators for each school. The use of percent proficient/meeting standards as a measure allows us to compare student performances across states that have different assessments and standards, or states whose assessments changed since the initiative started. Further comparison to nonparticipating schools within a district enabled us to examine the achievement of students in ConnectED schools in the context of potential larger patterns in the districts or states.

Impact Study Analysis

As mentioned previously, we first matched ConnectED schools with similar schools in the same district using propensity score matching, which yielded 180 comparison schools very similar to the 42 ConnectED schools in terms of % White and % FRPL students, and pre-initiative performance levels in ELA and math. Based on these matched schools, we estimated the potential impacts of participating in ConnectED on student achievement in ELA and math through a three-level HLM model with grade, school, and district levels. The model examines the impact of the Apple and ConnectED Initiative on schools' % proficient/meeting standards in ELA and math after 1, 2, and 3 years since the initiative started.

To further adjust for confounding factors possibly associated with participation in ConnectED and differences in post-ConnectED achievement between participating schools and their comparisons, our models accounted for schools' baseline differences in test performances and demographic indicators. Because schools started the Apple and ConnectED Initiative at different time points, we grouped the ConnectED schools into two categories. Schools that started the intervention between December 1, 2014 to November 30, 2015 belong to the 2015 cohort, whose spring 2015 test performance is considered the baseline performance (based on the assumption that students need at least six months with the devices before we might expect to start seeing an effect on achievement scores). Schools that started the intervention between December 1, 2015 to November 30, 2016

belong to the 2016 cohort, with their spring 2016 test performance as the baseline performance. Table 8 presents the academic years for each cohort of schools for each year of the impact analysis. We examined the impact of the initiative after 1, 2, and 3 years of ConnectED implementation for both cohorts of schools combined. We also examined the growth in student performance over the four years from the baseline to the end of year 3.

Table 8. Years in the Apple and ConnectED Initiative by cohorts of schools

	Spring 2015	Spring 2016	Spring 2017	Spring 2018	Spring 2019
2015 Cohort	Baseline	Year 1	Year 2	Year 3	
2016 Cohort		Baseline	Year 1	Year 2	Year 3

Correlational Study Sample

For the analysis linking student achievement to ConnectED-facilitated experiences and practices, SRI sought individual student data from all the 42 schools identified for the impact study. Four school districts, yielding a total of seven ConnectED elementary schools, responded in the affirmative to the request. Table 9 displays the number of teachers and students within these schools.

Table 9. Student and teacher sample for the correlational student achievement study

	SY 2016-17	SY 2017-18
Teachers	25	24
Students	604	577

Correlational Study Data Collection

SRI collected individual student demographic and achievement data from spring 2016 to spring 2018 from seven ConnectED elementary schools in four school districts. To link teacher survey responses on practices in 2016-17 and 2017-18 to student achievement during these years, we also collected teacher-student link data in these two academic years for the seven ConnectED schools.

Correlational Study Analysis

We linked teacher-reported ConnectED-facilitated experiences and practices in the 2016-17 academic year (from the spring 2017 teacher survey) to the performance progress of each teacher's students from spring 2016 testing to spring 2017 testing. We likewise examined teacher reported ConnectED-facilitated experiences and practices in 2017-18 (from the spring 2018 teacher survey) to their students' progress from spring 2017 testing to spring 2018 testing. Student progress in a given year is estimated by modeling student outcome at the end of the year while adjusting for the student's prior-year achievement. Table 10 presents the timing of prior-year achievement and outcome achievement linked to each year of the teacher survey. We were able to link 23 teachers who responded the survey to their students in 2016-17 and 2017-18, with a total of 46 teacher responses linked to 1106 students across the two years.

Table 10. Timing of prior-year achievement and outcome by teacher survey year

	Spring 2016	Spring 2017	Spring 2018
Teacher-report 2016-17	Prior-year achievement	Outcome	
Teacher-report 2017-18		Prior-year achievement	Outcome

The measures from the teacher survey used in this analysis include teacher attitude toward technology; student deeper learning skills including collaboration, personalized learning, communication, and real world engagement; student engagement and general learning skills; student and teacher technology use; teacher-reported teacher and student experience with ConnectED; and a ConnectED sustainability indicator. We also examined school general leadership and environment indicators. All these indicators came from the teacher survey and therefore only represent teacher perspectives.

For each ConnectED-facilitated experiences or practices indicator and for ELA and math separately, we posited a two-level HLM model with student and teacher levels, using the ConnectED-facilitated experiences or practices indicator as the predictor of the student outcome in that year, while adjusting for student prior-year achievement and demographic variables such as gender, ethnicity, English learner status, and special education status.[11] We also adjusted for school-level fixed effects to control for students' shared experience within schools.

[11] We did not include FRPL status because there was very little variation on this variable given that 96% or higher of the school's students had to be eligible for free or reduced-price lunch to participate in the Apple and ConnectED Initiative.

Conclusion

Over the six years of the Apple and ConnectED Initiative, SRI conducted a rigorous program of research on its implementation and outcomes for participating students, teachers, school leaders, and communities. This report has described the mixed-methods research design, including the theory of change and conceptual framework grounding the research and the methods employed in its five complementary substudies. Together, the substudies yielded a breadth and depth of data that provided as complete a picture as possible of this large, complex initiative and offered multiple perspectives on its successes and challenges. The report serves as a complement to study reports that present results and discuss findings, available on the SRI website at https://www.sri.com/case-studies/evaluation-of-the-apple-and-connected-initiative/.

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Appendix

Figure A1. The Apple and ConnectED Initiative Theory of Change

Context:

- Apple's ConnectED program as part of the White House's ConnectED Initiative
- Impoverished communities; great disparities in educational quality, access to resources, local opportunity and role models
- Decades of Apple experience in successful educational transformation

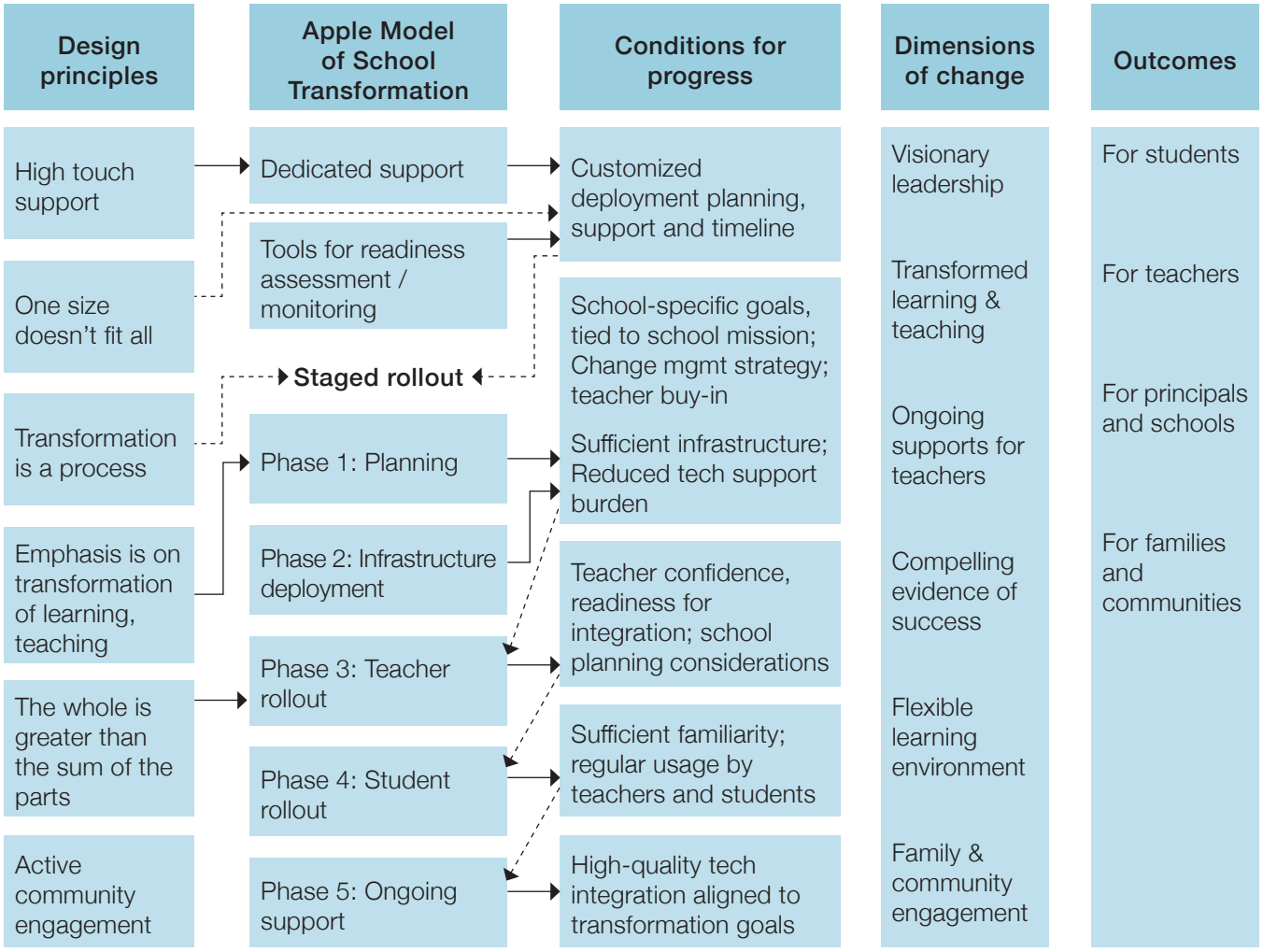


Figure A1. The Apple and ConnectED Initiative Theory of Change (Continued)

Program Outcomes

Short-term outcomes (during life of initiative)

Students	Teachers	Principals and Schools	Family and Community
★ Academic achievement (learning, advancement) ★ Deeper learning (e.g., collaboration, communication, critical thinking) ★ Engagement (positive academic behaviors, attendance, persistence) • Sense of future self • Self-efficacy & empowerment • Increased awareness of opportunities • Tech/info literacy • Social responsibility	★ Strengthened innovative teaching, facilitation of student-centered learning, and powerful uses of technology ★ More positive dispositions toward student capacity ★ Increased teacher persistence, commitment, and satisfaction • Use of data to support improvement	★ Strengthened principal instructional leadership ★ Increased principal persistence, commitment, and satisfaction • Use of data to support improvement	**Family:** ★ Caring adult engaged in each child's learning & in school ★ Improved communication; reduced language barriers • Parent satisfaction **Community:** ★ Stronger community connections • Cultural congruence and expression

Long-term outcomes

Students:

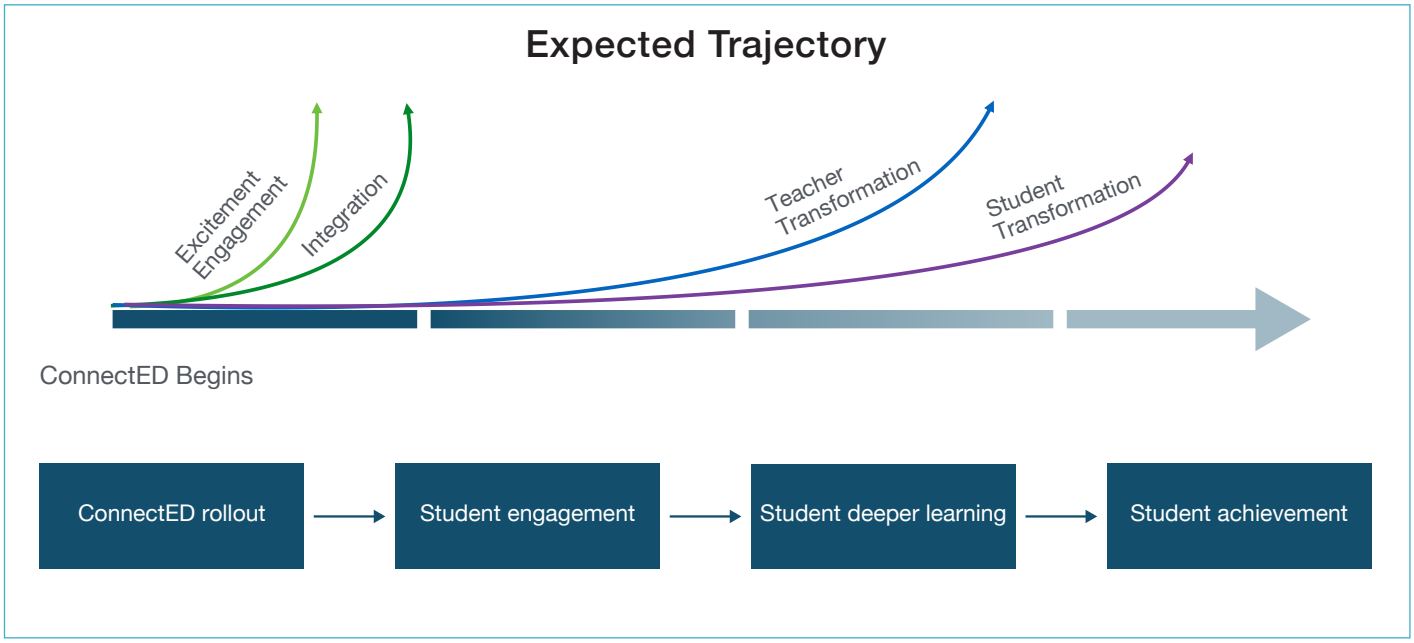
- More rigorous course selection
- College and career readiness

Family and Community:

- Enhanced scholarship opportunities
- Career development for parents
- Local workforce development; increased local capacity
- Improved health and wellness in the community
- Increased return rate to community (talented people come back)
- Lower crime rate, higher property values

➔ **Break the cycle of poverty**

Figure A1. The Apple and ConnectED Initiative Theory of Change (Continued)



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