1:1 Teaching and Learning in the Apple and ConnectED Initiative:

Lessons from Early Implementation

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Authors

Linda Shear, **SRI International**
Jessica Mislevy, **SRI International**
Andrea Beesley, **SRI International**
Emi Iwatani, **Digital Promise**
Shuai (Sam) Wang, **SRI International**
Deepa Patel, **SRI International**
Haiwen Wang, **SRI International**
Natalie Nielsen, **N-Squared Consulting**
Sarah Gerard, **SRI International**
Carmen Araoz, **SRI International**
Candice Benge, **SRI International**

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Executive Summary

Technology, such as iPad™ devices for students and teachers, has the potential to energize classrooms and bring substantially new types of learning opportunities to children of all ages. These changes are not an automatic result of adding technology to education, and they often take place over a long period of time. This report asks the questions, what does a promising start look like and what types of support can enable conditions for success?

We ask these questions through the lens of the Apple and ConnectED Initiative, which has been the focus of a rigorous 6-year research study. Launched in 2014, the Apple and ConnectED Initiative has supported 114 participating schools across the country with an iPad for every student. Schools received a host of programmatic supports including extensive professional learning opportunities for teachers and leaders, technology infrastructure upgrades, and process management.

The initiative and this research are explicitly situated in a diversity of traditionally under-resourced communities, with schools ranging from pre-K to secondary and from the inner city to rural migrant communities to Native American villages. This report focuses on the first year of iPad use across these schools to describe the initial changes that might be expected to appear when sufficient support is in place to lower common barriers to its adoption.

The report describes early implementation in three successive stages:

1. **Access:** Many of the ConnectED schools saw daily iPad use across multiple subjects, even early in implementation. This level of use was facilitated by strategic and technical preparation prior to the introduction of the iPad devices, coupled with initial strategies for their instructional application. Daily widespread use demonstrated how universal technology access has the potential to "level the playing field" and broaden students' horizons.
2. **Integration:** In classrooms where iPad use had become the norm, the learning environments looked different from those in typical classroom settings. In particular, iPad classrooms leveraged immediate access to rich information, offered new opportunities for expression, used technology to increase student engagement, and benefited from more organized and efficient workflows.
3. **Innovation:** In addition to more active and engaging learning environments, technology is often seen as holding promise to facilitate meaningful changes to students' opportunities for learning. This study uses a framework for "deeper learning" to describe emerging opportunities for teamwork, critical thinking, and other skills that prepare students for success beyond the classroom. Teacher surveys and a review of lesson plans reveal some initial steps toward deeper learning for a broad range of teachers, particularly in the dimensions of personalization and communication/creation that were most directly enabled by the affordances of the new iPad devices. More advanced opportunities require careful and creative lesson planning, and were most likely to be seen in the classrooms of teachers who held deeper learning as an explicit goal.

Lessons learned

- **In technology initiatives, initial excitement can deepen into ongoing engagement in learning.** While uptake varied predictably across classrooms in this initiative, initial student enthusiasm was a common theme, and iPad use became a core feature of many classroom routines in ways that energized environments for teaching and learning and expanded active participation in academic activities.
- **Some affordances of iPad devices seem especially advantageous for English learners and other students facing learning barriers.** For example, built-in tools on the iPad easily enabled the creation of learning products that required students to articulate their knowledge and ideas aloud, with encouragement to listen to and re-record their own voices in order to strengthen language production skills as they solidify subject matter understanding.
- **Even productivity tools can be used in creative ways to push learning environments in new directions.** While a substantial app selection was available for instructional use, many teachers made extensive use of built-in tools such as Keynote and Pages to facilitate instructionally meaningful new opportunities for student research and multimedia communication across subject areas.

- **High-quality support matters.** Essential enablers of success highlighted in this report include ongoing and tailored professional learning opportunities for teachers; strategic planning structures and coaching for school leaders; a clear, shared instructional vision; and district-level support for the initiative.
- **Technology can provide meaningful instructional change even in the early phases of implementation. Real innovation in learning opportunities requires purposeful planning and encouragement.** In the hands of motivated and creative teachers, the iPad-enabled learning environment provided strong facilitation for extended student academic projects that allowed students to think critically, collaborate in teams, and address meaningful real-world challenges. As always, these deeper changes to instruction require vision, exemplary models, and time to grow beyond initial learning curves.

Introduction

In a remote school that serves primarily Native American students, the fourth grade English class is a hive of coordinated activity. Students are each using tools on their individual iPad™ to complete a fast-paced series of activities that are centrally coordinated and displayed on a screen at the front of the room: reading aloud from a book about a wolf pack; using a design of their choice to diagram the similarities and differences of two main characters in the book; drawing lines to connect synonyms in two columns of words. The teacher monitors students' work-in-progress from her iPad, selecting examples to display to the class via AirPlay™ to feed group discussion or asking a student to help if a classmate is struggling. Near the close of class, students are asked to fill in vocabulary words missing from sentences; the class erupts in cheers when the tally displayed by the teacher shows that nearly all of them got a sentence right.

The students in the scenario above attend a school that participated in the Apple and ConnectED Initiative: a large-scale effort that coupled 1:1 access to technology with comprehensive support in 114 schools in diverse, under-resourced communities across America. The scope of this initiative, along with the wide variety of schools and students it served, offers an unparalleled opportunity to investigate the early phases of 1:1 iPad implementation.

In addition to an iPad for every student and a MacBook for every teacher, the initiative provided infrastructure upgrades and a dedicated team of support professionals that offered project management, tools and coaching for school leaders, and 17 days of onsite professional learning for teachers. In designing the initiative, Apple purposefully offered a suite of services that research and experience show to be essential but often lacking in widescale technology initiatives.[1,2] As this report will describe, this offering allowed many of the participating schools to quickly begin to use devices and explore the learning opportunities they could bring to their students. As such, the first year of the initiative can offer an important benchmark for the types of instructional changes that may first emerge in a well-supported, whole-school adoption of iPad and related technologies.

This report is part of an independent 6-year research study, conducted by SRI International, that investigates both implementation and outcomes of the Apple and ConnectED Initiative. It looks across classrooms to learn what characterizes a ConnectED classroom after approximately a year of technology use, what elements of support are essential to these changes, and to discover opportunities for paths forward. Other reports in this series will continue the story where this report leaves off, looking at trajectories of implementation over time and what it takes to sustain and grow the new learning opportunities that technology can offer.

Background

Decades of research into 1:1 initiatives describe a range of outcomes and experiences for participants. The most promising studies show several ways these programs can improve a student's learning experience. For example, students have easier access to online resources which helps them conduct research and visualize content and ideas.[3,4] In some initiatives, they are more likely to experience student-centered pedagogy,[5,6,7] engage in small-group collaborative and project-based learning,[2,8,9] and experience individual, differentiated, and personalized learning.[6,7,10,11] Students in 1:1 classrooms may also write more often, for more purposes, and communicate with their teachers and classmates more easily.[7,12] Studies have reported that students in new 1:1 environments are typically more engaged than they were before,[9,13] although initial effects may wear off over time.[14,15] In some studies, 1:1 programs eventually resulted in significantly increased achievement in mathematics, English language arts (including writing), and science.[16,17,18,19,20]

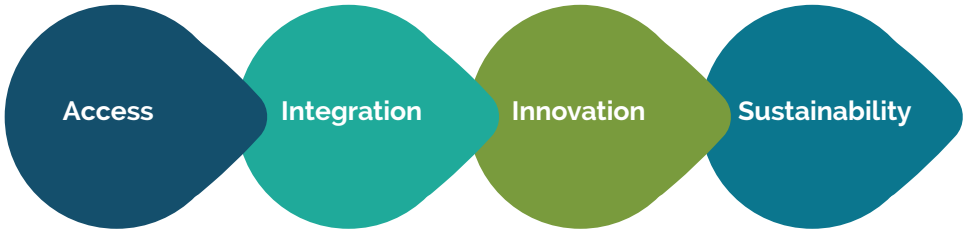
However, simply providing 1:1 technology does not always result in improvements to teaching and learning—digital access does not necessarily lead to educational innovation.[21,22] Some analyses show that devices and software purchased for teachers and students sometimes go completely unused.[23,24] When schools do implement technology, their approaches to using it differ between programs, classrooms, and schools; and how students and teachers use devices makes a difference in outcomes.[3,23,25] This is particularly true for 1:1 programs intended to reduce inequities and remove barriers for students in traditionally under-resourced schools and communities.[1,23,25] For example, students in these settings may be less likely to get instruction focused on critical thinking skills and tend to work with devices more as users rather than active producers, while the opposite is true for their more privileged counterparts.[21,26] These findings point to the importance of understanding how 1:1 programs are implemented and how implementation leads to changes in the learning environment, especially for students in under-resourced communities.

Apple's focus on supporting the process of implementation in schools began in their early Apple Classrooms of Tomorrow (ACOT) research collaborative[i] which demonstrated that "(m)eaningful use of technology in schools…goes far beyond just dropping technology into classrooms".[27] Subsequent research into the implementation of 1:1 programs makes clear that successful transformations in teaching and learning require buy-in at every level of educational institutions,[23,28] strong leadership,[6] extensive professional development,[1,4,22,23,29,30] technical support,[29] and a culture of professional learning.[2]

Based on this research, the Apple and ConnectED Initiative focused the design of the initiative on implementation, with the hope of setting ConnectED schools on a path toward integrated, innovative, and sustainable uses of technology to support meaningful new opportunities for students. Exhibit 1 describes the anticipated phases of this trajectory.

[i] Launched in 1985, ACOT was a research collaboration between Apple, universities, and public schools that lasted 10 years and provided extensive data on the opportunities and dynamics of early 1:1 technology in classrooms.

Exhibit 1. Phases of implementation



- **Access to technology:** devices are available, charged, connected, and ready for active use in the classroom.
- **Integrated technology use:** device usage regularly plays a fundamental role in teaching and learning.
- **Innovative technology use:** devices are facilitating meaningful changes to students' learning opportunities.
- **Sustainable technology use:** conditions are in place to facilitate both continued integration and continued progress toward innovation.

This report focuses on Apple and ConnectED classrooms approximately 1 year into implementation to understand the initial steps in the evolution of teaching and learning. While the four phases above represent a multiyear process, we use the first three phases to frame our exploration of what is possible early in the implementation phase of a 1:1 program, particularly in traditionally under-resourced settings, when typical barriers to access are removed.

Topics discussed in this report:

- An introduction to **the Apple and ConnectED Initiative** and to the research that produced this report
- **Access to Technology** documents the use of devices in classrooms and across subject areas to illustrate how always-available technology access can lead to active use in teaching and learning
- **Integrated Technology Use** identifies common themes across varied settings to provide a picture of what a highly integrated classroom looks like
- **Innovative Technology Use** documents promising examples of deeper learning as a preview of the future potential of a well-implemented 1:1 initiative
- **Key Factors Supporting Implementation** looks at the mechanisms behind the findings presented in earlier sections to understand what elements of support are essential to a successful program
- **Lessons Learned** summarizes key findings with an eye towards informing the design of future initiatives

The Apple and ConnectED Initiative

Launched in 2014, the Apple and ConnectED Initiative has supported 114 participating schools across the country, with the ambitious goal of transforming educational and life opportunities for students in America's most under-resourced communities. The schools ranged from pre-K to secondary and serve students from a variety of communities including urban, rural, migrant, and Native American communities. As a requirement to apply to the program, 96% or more of each school's students had to qualify for free or reduced-price lunch. The initiative thus offered a unique opportunity to study technology adoption across a wide range of high-poverty contexts.

Guided by research and by Apple's long experience in classrooms, the design of the initiative reflects the understanding that program success requires strong leadership[31] and a range of ongoing implementation support.[32,33] To achieve this, the initiative offered a longterm partnership with each school that provided comprehensive support including devices (an iPad for every student and technology for every teacher), infrastructure upgrades and project management, a dedicated team of professionals to support leadership and teachers, onsite teacher professional learning in the first year after rollout, and other support offerings. Recognizing the diversity of the participating schools, the initiative also customized both implementation timelines and professional learning approaches to meet the unique needs of each school setting.

Exhibit 2. Tools and support provided to Apple and ConnectED Schools

Devices	**Schools received an iPad for each student and teacher, a MacBook for each teacher, and an Apple TV in every classroom.**
Infrastructure	**Apple and its partners provided Wi-Fi and other infrastructure upgrades, as well as classroom device management and other management applications.**
A dedicated support team*	**Included (1) an Apple Development Executive (DE) to support school leadership in visioning, instructional leadership, and change management; (2) a dedicated Apple Professional Learning (APL) Specialist, who was onsite at the school for a total of 17 days in the first year after rollout to provide individualized professional learning offerings related to technology integration through a coaching and mentoring model; (3) a Project Manager (PM) to manage and guide the process of implementation and coordinate support providers; and (4) a Project Engineer (PE) to support technical issues.**
Tech support	**Schools had access to a dedicated Project Engineer and AppleCare hardware and software support as needed. This technology support included ongoing assistance for any technology-related issues, including those associated with hardware, operating systems, and wireless infrastructure, as well as coaching for school IT professionals.**
Digital learning resources	**Teachers and students had access to a wide range of apps and educational resources available from Apple's App Store, iBooks Store, and iTunes.**

*DEs and APL Specialists are all education professionals on Apple's staff with experience as educators in the field.

Apple and ConnectED Research

The study included multiple complementary components: surveys of school leaders, teachers, and students; case studies of selected schools; rubric-based analysis of learning opportunities through the lens of lessons and student work samples; and a study of achievement outcomes. See a complete description of methods for this study in Shear et al., 2021.[34]

Since this report focuses on early implementation during the first couple of years the initiative was rolled out in schools, data emphasized are mainly from 2015–17.[ii] Rather than a "one-size-fits-all" approach and timeline, Apple and ConnectED initiative leaders believed strongly in the need for implementation to follow paths appropriate to each school's context and readiness. The site visits that ground this report were conducted between 6 and 16 months after student device rollout in each school, depending on rollout schedules and school readiness to host a visit. As a result, while this report summarizes early implementation after about a year, specific status of the initiative at each data collection varies by school.

One Size Doesn't Fit All

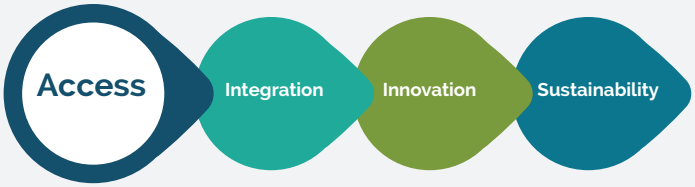
Hallmarks of the Apple and ConnectED approach:

- Intensive, personalized support
- Adaptable, not prescriptive: path, pace, and goals all vary by school
- Leadership and infrastructure readiness before device rollout
- Technology as an enabler for learning and teaching

Exhibit 3. Data that contributed to this report

Case studies of 12 schools, *spring 2016-spring 2017*	Case study school visits included interviews with the principal, 4-8 teachers, and other school staff; observations of the interviewed teachers' classrooms; focus groups with students and with parents; and discussions with partners and community members as appropriate.
Teacher surveys in 101 schools, *fall 2015 and spring 2017*	n=2610 (response rate 81%) and 2432 (response rate 77%
Principal surveys in 101 schools, *spring 2015 and spring 2017***	n=97 (response rate 96%) and 83 (response rate 83%)
Student surveys in 15 schools, *spring 2017*	n=1828 (response rate 71%)
Collection of lessons and student work in 9 schools, *spring 2016-spring 2017*	n=40 teachers, 198 lessons

[ii] See also Singleton et al. 2018[40] which reports on survey-specific findings from the same period. Other reports in this series will look at how the results reported here have sustained and evolved in later years.



Access to Technology

In some 1:1 initiatives, and particularly in under-resourced settings, infrastructure issues and lack of teacher training often lead to devices being under-used. In many of the Apple and ConnectED schools, extensive programmatic supports included devices and infrastructure as well as professional learning designed to get teachers comfortable quickly with a range of ways to use the tools. The combination of stable access and teacher preparation appears to have averted some of these initial challenges. This section describes the resulting frequency of early classroom use and the immediate benefits that access brought to students.

Key Findings

1. Daily iPad use was high across most classrooms.

2. iPad usage was strong across subjects.

3. Universal technology access "leveled the playing field" and broadened students' horizons.

Daily iPad use was high across most classrooms.

As with any widespread initiative, ConnectED classrooms exhibited a lot of diversity in how much devices are used. But on average, our data suggest that after about a year, the majority of teachers had succeeded in integrating the iPad devices into students' everyday classroom activities. This is true (with some variation) across grades and subject areas.

Exhibits 4 and 5 show that both teachers and students reported high levels of daily iPad use: 75% of teachers across all schools, and 82% of students across 12 of 13 surveyed schools. Nevertheless, these high averages mask some variance in usage across schools. For example, at the 13th school that completed student surveys, just 47% of students reported daily

> I think it's... a part of the school now. I don't even know if the students see it as ConnectED. They just see it as this is how we learn. This is what we do. This is how things are.
>
> – Middle school teacher

iPad use. In that school, students were allowed to take their devices home, and teachers told us that the students would often forget to bring them back or forget to charge them, which interfered in everyday use. Teachers' varying comfort levels were also an obstacle in some cases; a technology-supported classroom came with a steep learning curve for many teachers, which some were still navigating at this early stage of implementation.

Exhibit 4. Teachers reported high daily student iPad use

75% report daily student use

95% report at least weekly student use

67% report typical use for half of a class period or more

ConnectED teacher survey, spring 2017

Exhibit 5. Students reported high daily iPad use

82% report daily use

98% report at least weekly use

ConnectED student survey, 12 of 13 surveyed schools, spring 2017

In general, high levels of use were evident across subjects. While the most frequent daily use was reported in elementary schools, the pattern of high usage across subjects held in middle and high school as well (Exhibit 6). This high frequency of use was particularly notable in math, as some other research had noted that this is the subject in which technology integration is often the most difficult for teachers to achieve.[1,35]

I use them nonstop. I use them every day in my classroom. Every day.

– High school teacher

Exhibit 6. iPad use was strong across subjects

Daily iPad use was reported by...

59% of math teachers

73% of English teachers

57% of social studies teachers

68% of science teachers

ConnectED teacher survey, spring 2017, middle and high school teachers only

Universal technology access "leveled the playing field" and broadened students' horizons.

In most observed classrooms, iPad devices and connectivity were available to teachers and all students all the time. Before the initiative, teachers were unable to plan their instruction in ways that meaningfully integrated technology because of unreliable, difficult to schedule, or differential access (with some technology initiatives that supported only academically advanced students, for example). In contrast, widespread access gave teachers more freedom and confidence to embed ConnectED resources into their instruction.

I kind of shied away from some of the research things in the past because we didn't have enough access to the resources… Now it's like, 'Okay, guys, we can research anything at any time.'

– Middle school teacher

As a result, principals, teachers, and parents reported a more level playing field. On-demand access to state-of-the-art technological tools and resources were seen as preparing students facing learning barriers for success in the 21st century and increasing equity in schools where technology had previously been given only to students in advanced tracks. Sometimes this impactful access extended to the surrounding community. For example, some schools opened access to families after school hours for job-seeking or other personal needs because connectivity at home was rare, and free computer access at the library came with a line that stretched out the door.

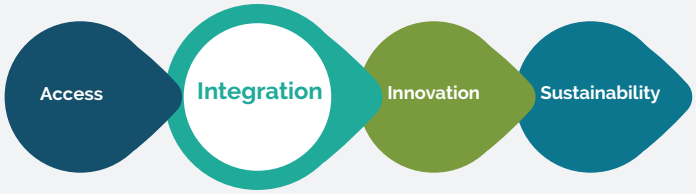
It put us… on an even playing field with the other students not just in the [region], but almost nationwide… and I love that.

– Elementary teacher

Some ConnectED schools were geographically isolated and others served specific communities with limited access to outside resources. In many of these schools, principals, teachers, and parents reported that students have bounded life experiences and are not exposed to the same things as their more privileged peers. For these students, on-demand video, virtual exploration, and other immersive access to people and places outside the community were important extensions of their experience.

We are very sheltered here. Just having access to internet at our fingertips has opened their eyes to more of the world around them.

– Elementary teacher



Integrated Technology Use

An important hallmark of the initiative is that it did not try to impose a particular pedagogical framework or model of use. Teachers were introduced to several possibilities and encouraged to integrate the technology into their curriculum as they saw fit for their students. Not surprisingly, we saw considerable variation in what a "ConnectED classroom" looks like. But in classrooms where iPad use had become the norm, learning environments often shared some characteristics that represented substantive departures from how students engage in learning in more typical classroom settings. In this section, we describe these common characteristics of ConnectED learning environments and how they appeared to have benefitted students.

Key Findings

1. Immediate access to rich information and resources allowed students to exhibit more autonomy, self-direction, and motivation.
2. New opportunities for expression let students demonstrate their learning in a wider variety of ways and let teachers better understand student progress.
3. Student enthusiasm about new structures for classroom participation led to higher engagement and, in some cases, a greater willingness to take risks.
4. Integrated technology use facilitated more organized and efficient workflows.

Immediate access to rich information and resources allowed students to exhibit more autonomy, self-direction, and motivation.

Looking up information became core to teaching and learning during early implementation and was reported on surveys as one of the top iPad uses in the classroom. In 2017, 39% of students in the surveyed schools reported that they looked up information every day. The information students found went far beyond what was available in the schools' libraries: they could research current events, easily compare different perspectives on an issue, and learn about a variety of topics through images, videos,

and multimedia sites. Beyond using external resources such as search engines, news sites especially for students, and online dictionaries as part of their assignments, students often looked up answers to questions that arose in class discussions or their work, or sought more information based on personal interest or need.

Many teachers reported that real-time access to information positively changed classroom dynamics. Students could find information for themselves in real-time, and teachers could focus on conceptual topics instead of answering basic questions. Several teachers also reported becoming increasingly comfortable not having all the answers and letting students find information.

However, technology integration is not a panacea for common challenges around classroom management and rigorous curriculum. Sometimes technology integration highlighted the need for teachers to increase capacity in these areas. For example, in some classrooms access to external resources led to increased cheating and distraction. A few teachers and students also mentioned that 1:1 access could compromise learning and critical thinking by allowing students to easily look up answers. After a year of implementation, teachers and schools were finding ways to address these new complications. Some schools used management software to help teachers monitor or control student activities, and some teachers used deliberate classroom management practices related to iPad use. Some teachers were also beginning to apply the rule that if a question can be answered by a simple web search, the lesson approach should be re-worked to require more thoughtful analysis.

> That is a huge shift in our teachers. Realizing that maybe they don't have all of the answers, but we can find those answers together… I think the relationship with the teacher and the student is changing because of that for that better.
>
> – District representative

> You can always tell students who have gone back and watched some videos or read some new things…The question[s] that they ask are very intelligent question[s], deeper answering and so forth.
>
> – High school teacher

> With [my child], he's more interactive with what he's learning… It feels good that they have the capability to look at all of these things during their lecture.
>
> – Middle school parent

A Student Shares Just-in-Time Information to Support a Classmate

In a fifth-grade science class, the teacher asked students to select an African American inventor to research for an essay and to search online to inform their decision. One student chose the inventor of the Super Soaker water gun. When the teacher realized that an English learner student did not know what a Super Soaker was, she asked the student to AirDrop a picture of a Super Soaker to his classmate so that the classmate could follow the conversation.

Finding ways to address these challenges is likely a worthwhile endeavor given reports that iPad integration led to students exhibiting more autonomy, self-direction, and motivation. The ability to pursue answers to their own questions in class was empowering for students and sometimes led to the discovery of new interests. This increased self-directedness was seen as particularly important in the context of the populations served by the Apple and ConnectED Initiative. One teacher whose students were growing up in difficult circumstances said that because they perceived limited agency in their lives, they tended to wait for the teacher to answer their questions. The fact that they were now learning they could use the resources at their fingertips to pursue answers to their own questions was a game-changer.

New opportunities for expression let students demonstrate their learning in a wider variety of ways and let teachers better understand student progress.

Apps such as Pages, iMovie, and Keynote enabled students to display their thinking to the teacher and other students in more and different ways than before the initiative. Creating pictures or images and recording themselves and others were especially beneficial for students who had difficulty expressing themselves in writing. Students reported that these opportunities helped teachers know them better academically and personally. Indeed, during early implementation, teachers reported using technology to monitor student thinking and understanding far more frequently than before the initiative, with 76% indicating that they did so at least once a week (compared with 46% at baseline). Teachers also believed that when students learned through apps that were familiar to them, such as iMovie, they learned content more deeply without even realizing it.

> I think it has made us as teachers more flexible. It has given us more opportunities to change things and have students produce things that we couldn't do before and that would show different learning in different ways.
>
> – High school teacher

> I think every kid can show off that they're brilliant, if they have an appropriate way to do that… [With an iPad,] kids who didn't have a voice or didn't have success are able to find an outlet.
>
> – Elementary teacher

Video Helps Students Articulate Their Mathematical Reasoning

In math class, a pair of students were preparing to develop a video recommendation to their school board about the most cost-effective textbook to buy, based on data about costs for different numbers of units. With a Numbers spreadsheet the teacher shared with them and other tools available on their iPad, students used algebra to compare costs and develop graphical representations and then began to plan their videos. The teacher set the requirements of their videos as if it would be an actual presentation: it had to capture the logic of their argument in just 30 seconds because "school district professionals are busy people!"

Spotlight: English Learners

When English learners had more opportunities to practice language, their skills improved. In schools with high populations of English learners, teachers reported that literacy skills, confidence, and the pace of language acquisition improved greatly. Experienced educators called the pace of improvement "remarkable." Many believed this improvement was supported by the technology that allowed teachers to embed video and audio recordings of students' explanations into their assignments and students to listen and re-record themselves until they liked how they sounded. In addition, the requirement to speak their explanations out loud in math and science helped students solidify subject matter understanding as they practiced their English. For example, in one high school that served immigrant students who are nearly all new to the English language, students in an advanced mathematics class used mathematical modeling to control the motion of a roller coaster, then recorded a 3-minute video to explain how they did it.

> They film themselves, record themselves…listen to it, and kind of fix it…They got giggly in the beginning because they didn't want to hear themselves. [English learner] students don't speak because they're embarrassed of their accent, they're embarrassed that they might mispronounce something. But this has opened up a whole new world where they're OK with talking now.
>
> – Middle school teacher

Student enthusiasm about new structures for classroom participation led to higher engagement and, in some cases, a greater willingness to take risks.

In many classrooms, built-in iPad features as well as apps such as Nearpod and Quizlet facilitated the central coordination and display of whole-class activities that teachers directed, and students completed individually on their devices. In many classes, a lesson consisted of a series of activities that were introduced centrally and carried out individually on each student's iPad, then integrated and shared for discussion. These activities went beyond the model of a simple classroom response system: students might be writing, drawing, or accessing a variety of apps to complete their tasks. Even in a simple vocabulary lesson, these structures were creating environments where everyone's responses mattered, and no one could hide.

> It keeps them accountable for their work. They really grasp and take ownership… They've never had to really be in charge of their own learning… Now, they're really having to learn.
>
> – Elementary teacher

Accordingly, student engagement in the learning process was a widely reported benefit of the initiative. Examples included reports of students being eager to return to school after a break, excitedly sharing more with their parents about what they are learning in school, showing more enthusiasm for and completion of homework, and spending time improving and personalizing their work after they had completed an assignment. Similarly, teacher and principal surveys showed gains in aspects of student engagement such as going beyond expectations and student pride in the products they created. There were also some reports of increased class attendance and fewer classroom discipline problems.

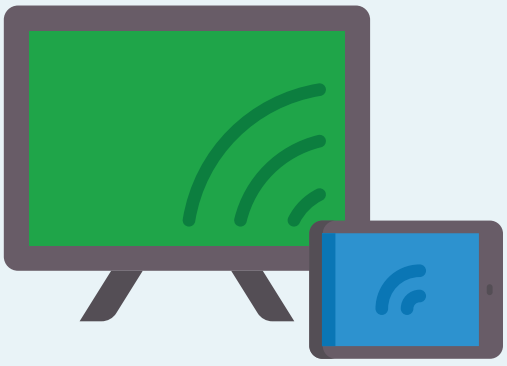
> That apathy and hesitance and resistance I mentioned from my students—technology breaks those walls down… [It] has helped them to share out in the group and take more academic risks.
>
> – Middle and high school teacher

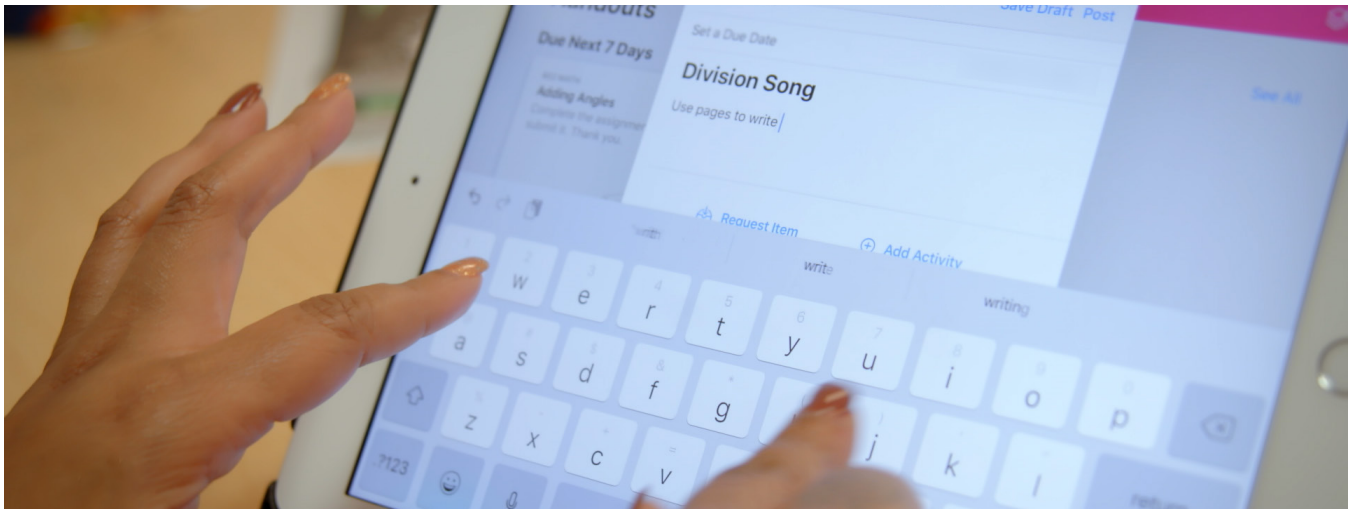
Students chose words like "helpful," "awesome," and "fun" to describe learning with an iPad, and generally reported in focus groups that they and their peers were much more engaged in class activities since the initiative began. We observed high levels of enthusiasm even for routine activities like practicing math or reading with the apps, particularly in more dynamic or fast-paced environments facilitated by Nearpod or learning games.

Some students were taking more academic risks. These structures promoted more equitable participation, information sharing, and individual accountability than traditional classrooms. Over time, students were becoming more comfortable knowing that their responses would be counted and displayed. Teachers said that older students in one school have a history of being "gun shy, not willing to take risks and share their voice," but they had begun participating more in class.

iPad Facilitates Student Collaboration

In a fifth-grade math lesson, students worked in pairs to create and complete a Numbers spreadsheet on integers, decimals, and fractions. The teacher used AirPlay extensively throughout the lesson, frequently calling on individual students to share their screens as they worked through the spreadsheet. Whenever a student's screen was displayed, the whole class discussed the work and provided feedback on the example that was being discussed, sometimes as the student whose work was displayed described their reasoning. This use of screensharing prompted whole-class collaboration in the context of a small group exercise and enabled the teacher to monitor student thinking.





Integrated technology use facilitated more organized and efficient workflows.

ConnectED classrooms often featured digital access to class materials and assignments, online submission of student work, and other organizational resources and streamlined workflows. In some schools, teachers and students routinely used the devices for seamless sharing of materials. Also, some teachers and students used apps such as Edmodo or Remind, or regular email, to keep in contact with teachers to ask questions outside of school hours. Teachers and students alike touted these resources as keeping them organized and helping classroom activities flow smoothly. Some teachers reported spending more time on learning because they were spending less time managing papers and books.

> It's better to use an iPad than using paper and pencil, because you are wasting paper, and you're gonna have to keep sharpening your pencil.
>
> – Elementary school student

Technology Helps High School Students Collaborate on a Group Project

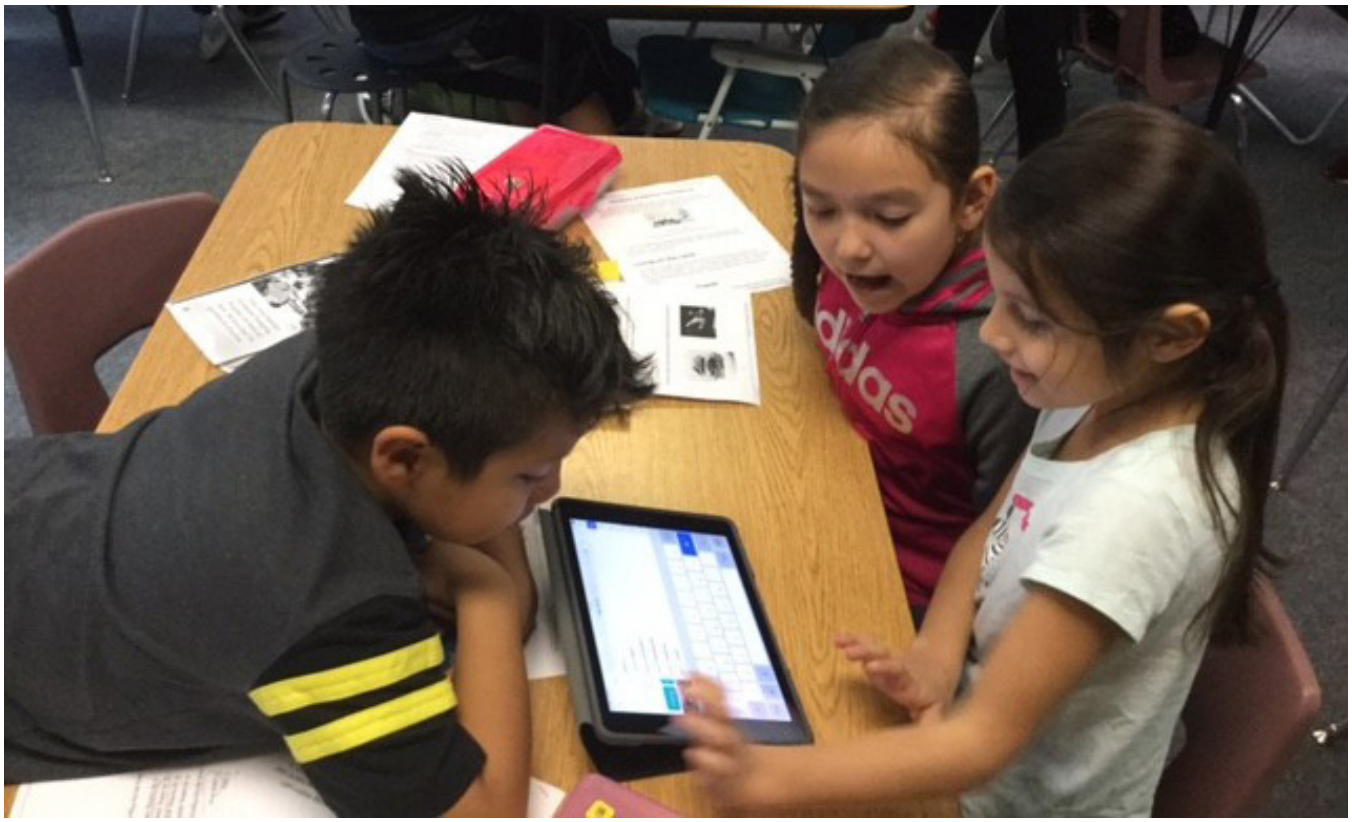
Sophomore English students doing a group project on the nonfiction book Night used the available technology to "divide and conquer." One student set up templates for the group's Keynote presentation. Another student researched content and used AirDrop to send it to the team, while a third student did the same with visual materials. With all of the components in one place and easily accessible, the team could work together to compile the information into their group presentation. 1:1 iPad access made it possible for all members to share the work equally and work efficiently on the assignment.

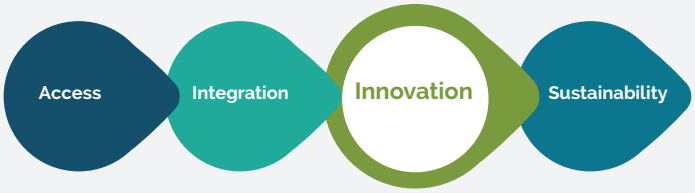
The ConnectED Learning Environment

While these attributes of the learning environment were common across ConnectED schools where students had been using their iPad between 6 and 16 months, they were not present everywhere or all the time. Some classrooms had all of these characteristics, while others were strong along one or more dimensions and just beginning to explore others.

The hallmarks of the ConnectED learning environment profiled here are in many ways directly supported by affordances specific to iPad devices and toolsets. For example, easy creation of multimedia work products to express learning or classroom structures that rely on organized communication employ apps that are built-in or easily available on the iPad (such as iMovie, Keynote, or AirPlay) and that can be incorporated productively into lessons in all subject areas and grade levels.

It is also important to recognize that these widespread changes in classroom learning environments were achieved within the context of a particular initiative. ConnectED schools had the benefit of extensive Apple Professional Learning, upgraded connectivity, and other support for successful adoption—conditions that can support pedagogical change,[2] but are not always in place when new technology is introduced in a school. Thus, what we describe here are learning environment changes that are relatively easily afforded by the features of the iPad, in implementations where every child has access to a device and where sufficient training and support is provided for leaders and instructional staff to enable them to take up the opportunity.



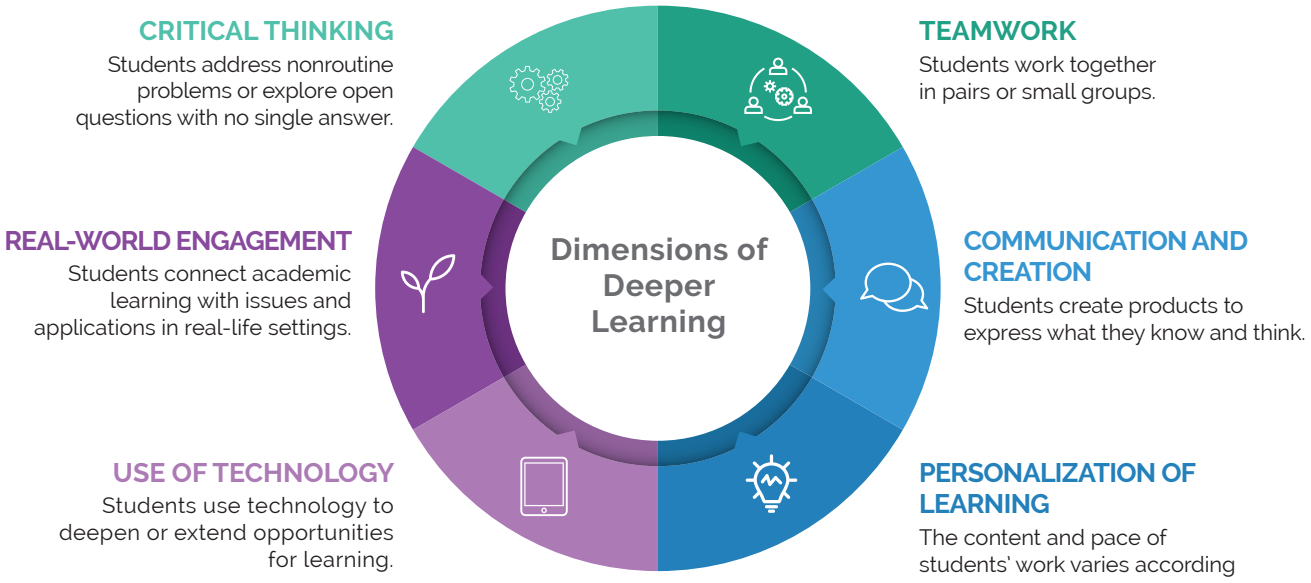


Innovative Technology Use

Beyond active and engaging learning environments, technology is often seen to hold promise to bring fundamentally new opportunities for student learning. In ConnectED Research, this type of learning innovation is examined in part through the lens of "deeper learning": opportunities for teamwork, critical thinking, and other skills that prepare students to be successful in the demanding and dynamic workplaces of their future. In some Apple and ConnectED classrooms, the new tools were important enablers for teachers whose goals included deeper learning.

This research applied several different lenses on the types of learning opportunities offered across ConnectED classrooms. A framework for deeper learning, described in Exhibit 7, marries constructs that learning sciences research[36,37] has shown to promote strong and lasting learning outcomes with the types of opportunities that iPad devices and tools can provide. This framework was elaborated into a set of rubrics that describe a progression of learning opportunities in each area. These rubrics were operationalized through several different types of data collection, including coding of sample lessons and student work, teacher surveys, and classroom observations, to draw conclusions about the opportunities for deeper learning present in early ConnectED classrooms.[iii]

Exhibit 7. The six dimensions of deeper learning used in ConnectED Research



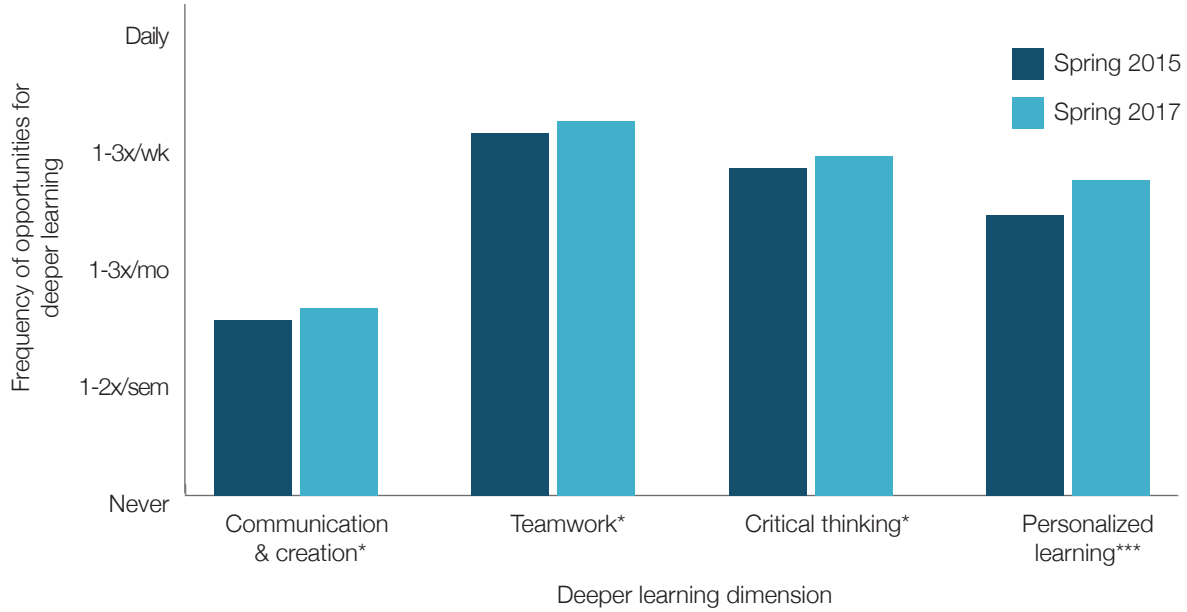
[iii] See Shear et al., 2021[34] for additional detail on the deeper learning framework and research methods.

It is important to recognize that the professional learning provided by the initiative was designed to be adaptable to the goals of a wide range of teachers and schools. A primary objective of the coaching provided by APL Specialists was to help each teacher become comfortable using the iPad devices in instruction and to offer an accessible repertoire of strategies for doing so that are aligned with local goals for teaching and learning, rather than to drive the ideas of deeper learning into every classroom. Deeper learning was likewise sometimes a focus of a particular school's goals as they adopted the new technology, and sometimes it was not. As such, this research sought to illustrate the elements of deeper learning that came most naturally to teachers as they began to use these devices.

Deeper Learning in Apple and ConnectED Classrooms

According to teacher surveys, the ConnectED initiative resulted in small but statistically significant increases in the opportunities teachers gave students to engage in deeper learning. The surveys asked teachers to report how often students in their classes performed specific activities that aligned with each deeper learning dimension. On average, teachers reported providing students with frequent opportunities for communication and creation, critical thinking, teamwork, and personalized learning after approximately one year of iPad use (Exhibit 8). In addition, some teachers described a shift in their classrooms toward being more student-centered and said that the devices created opportunities for new types of lessons to engage students in building knowledge in ways previously not available.[40]

Exhibit 8. Deeper learning shows some early growth

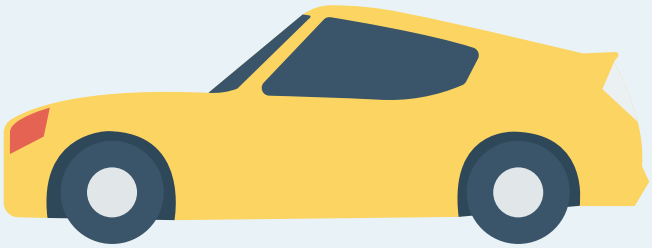


*Source: Teacher survey 2015 & 2017. *p < .01, ***p <.001. From left to right, number of respondents were 1168, 1271, 1241, and 1220.*

What Deeper Learning Looks Like in ConnectED Classrooms

Opportunities for deeper learning took different shapes in different schools, classrooms, and subjects.

How does mass affect speed? In an eighth grade science classroom, a student held a toy car at the starting line ready to be released. Another student held up his iPad ready to push start on the "Stop Motion" application to capture how long it takes the car to move from the starting line to the finish. Moments ago, the students predicted the times it would take for the car to move 50 cm and 150 cm, hypothesizing what the difference would be. After students capture the timing of multiple trials in a table in Pages, the teacher presented them with a new question: does mass impact the speed of the car? To investigate, the students taped washers to the car to add mass and repeated the trials to see how long it now took the car to move 50 cm and 150 cm. Students then analyzed the data they had collected. This lesson encouraged students to build their own knowledge about how mass relates to speed. iPad devices made it more efficient for students to conduct the experiment, quickly share their results with classmates, and engage in the activity in one class period.

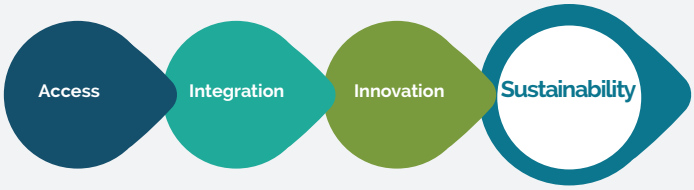


What patterns exist in history? Students in an eighth-grade social studies class worked in groups to look at how history repeats itself and what that can teach us. In one group, four boys debated events showing their chosen theme of "containment and appeasement" which may inform our understanding of a current event. Each student used an iPad to help take notes and facilitate the group's discussion: one used Padlet to organize their brainstorming of historical examples, the second referenced an electronic repository of students' work from earlier in the year to use as sources, the third captured the group's decisions and progress in Numbers, and the last displayed a slide with examples to include in the final product. This group has identified connections between Hitler, the Cold War, and ISIS. They discussed what type of product (e.g. iMovie; infographic, interactive poster, or timeline) would best convey how these events collectively represented containment and appeasement. The task required students to think critically about the relationship between events that occurred at different points in history and to work together to create a product. iPad use was a requirement for the lesson and assisted students with brainstorming ideas, organizing their work, and developing a product that best conveyed the group's thinking.

In ConnectED classrooms, the deeper learning dimensions most commonly reported or observed include personalization and communication: both opportunities that are directly afforded by the devices and related apps. Sixty-five percent of the sample lessons collected between spring 2016 and spring 2017 asked students to create a product to express what they know or think, often in tools such as Keynote or iMovie that offered multimedia features. Also, teachers whose goals for the students included critical thinking and other aspects of deeper learning found the iPad to be a powerful enabler: for example, they described how the range of device features and available apps could add authenticity and complexity to problem-solving tasks in which students design a house or a playground, allow students to engage virtually with phenomena in other times and places to enrich opportunities for comparative or historical analysis, or make it feasible for students to collect and analyze their own data.

> I really like [this lesson] because it wasn't just me spitting out info at them and them tuning me out. They are engaged and interacting with this lesson… 100% engagement. They are all trying to figure it out. [It] forces them to do their own thinking.
>
> – Middle school teacher

More frequently, however, the deeper learning opportunities we saw were more limited. Most often, teachers tended to use technology in ways that substitute for other ways to accomplish the task and don't fundamentally change the character of students' learning (e.g. using Numbers instead of a printed table to record data, or Keynote instead of poster board to compile and share factual information they had found online). While the devices easily enabled some initial steps toward deeper learning for a broad range of teachers, more advanced opportunities required careful and creative planning and were less likely to be seen in classrooms where deeper learning was not an explicit goal. Additional professional support that highlights the full spectrum of technology-supported learning opportunities could enable more teachers to begin to unlock the potential of these tools to support deeper learning for students.



Key Factors Supporting Implementation

While the changes to learning environments described here were facilitated by iPad devices and tools, they were by no means an automatic result of introducing the technology. The Apple and ConnectED Initiative was designed to provide a system of support to each school that Apple's long experience in classrooms suggested was key to success. Here we describe key factors that supported implementation at schools where early implementation was most successful. These include intensive professional learning support for teachers; coaching and planning structures for school leaders; a clear, shared vision for the program; and district-level support for the initiative.

Key Factors

1. Support for teachers
2. Support for leaders
3. Shared vision and clear expectations
4. District buy-in

Support for teachers

Apple Professional Learning (APL) offerings were an important and differentiating element of Apple's services to the ConnectED schools. An APL Specialist was onsite at each school for a total of 17 days in the school's first year after the iPad rollout, providing individualized professional learning for technology integration through a coaching and mentoring model. All APL Specialists were education professionals with experience as teachers and/or administrators. Professional learning services were intended to provide a custom program in response to the needs, interests, and capacities of each

school, with activities that typically included a mix of whole-group workshops, small-group activities, and one-on-one coaching. Consistent with research-based characteristics of effective professional learning,[32,33,38,39] the APL program was designed according to three primary pillars: Customized, Hands-On, Sustained.

Exhibit 9. Primary pillars of the APL program

Customized	Hands-On	Sustained
• Supports tailored to the school context • Classroom-based instructional coaching	• Intensive exploration and experimentation with iPad devices and apps • Teachers creating and developing their own projects	• 17 days of coaching per school in the first year • Additional remote support as needed • A suite of always available digital resources

At each school, APL experiences varied across the initiative. Overall reports were very positive, with more than half of teachers surveyed expressing that their professional learning experiences within the Apple and ConnectED initiative were more individualized, hands-on, and relevant to their needs than typical professional development offerings. In schools where the APL experience was most successful, it was marked by the following characteristics:

- **Exceptionally close relationship with the APL Specialist.** In many schools, the APL Specialist was commonly referred to as "part of the family." Teachers appreciated always-available support and being able to get any question answered and expressed confidence that the APL Specialist truly cared about their success and the success of their students. This bond is a unique aspect of the APL program and one of its key strengths.

> [APL Specialist] is amazing! Non-threatening, encouraging, positive. There are things I'd do and he'd say it blew his mind. It was basic but he was very encouraging, so it made me want to do more.
>
> – Middle school teacher

- **Professional learning activities that were customized to the schools' goals and teachers' individual goals for instruction.** APL experiences that worked well were attuned both to the school context and to teachers' specific goals and needs within that context. In a middle school with a history of strong faculty collaboration, APL opportunities included a monthly sequence of sessions in which teachers learned a variety of applications of a new tool or teaching strategy, then worked together to design a way to leverage it in an upcoming

> It was different and every grade level was different. Then, we could take what we learned and share it with the other grades, too. It wasn't that we were all trying to learn 15 things all at once; it was very individualized.
>
> – Elementary school teacher

lesson, tried it out, and discussed the results. Another principal provided the APL Specialist with a list of skills that teachers needed help on so that the APL could come prepared to target teachers' specific needs. That APL Specialist also worked directly with students to help them develop research projects.

- **Strong connections between the professional learning and what teachers were doing in the classroom.** Teachers found the professional learning to be especially valuable when it was directly connected to what they were teaching, anchored in their practices, and just-in-time. APL Specialists made these connections by providing feedback on lessons, modeling the use of apps in lessons, providing strategies or suggestions for specific instructional problems, and having teachers try assignments and later reflect with the APL Specialist.

Exhibit 10. Teacher-reported results of Apple Professional Learning

Across all ConnectED schools, as a result of Apple Professional Learning:

91%	of teachers are better able to select the apps and digital content they need
92%	are better at using technology to deepen students' content knowledge
95%	are more comfortable having students use technology in the classroom
88%	are more comfortable allowing students to take initiative in their learning

ConnectED teacher survey, spring 2017

These findings speak to the overall value of the professional learning opportunities that teachers received as part of the Apple and ConnectED initiative, across subjects, grade levels, and teacher proficiency with technology. At the same time, variations in how schools viewed their APL experiences revealed variations in the enactment of individualized coaching and underscored how difficult it can be to foster change across a wide range of contexts.

> In the trainings, it was so… easy to take in what was being given, and it was exciting to get out of the room quick to go try it and to go make it…. I was so excited about it because I was actually learning to do something that I was afraid to do.
>
> – Middle school teacher

Even in schools with strong implementation and APL experiences, teachers identified ongoing needs for professional learning, including more emphasis on content-specific instructional strategies and more opportunities to learn from peers within and beyond their schools. As schools' 17 days with their dedicated APL Specialist came to a close after the first year of implementation, many were still considering how they would support the continued evolution and deepening of teachers' iPad-supported instructional practices with reduced external support.

Support for leaders

In the Apple and ConnectED Initiative, support for leaders was an important enabler to successful startup and implementation of the 1:1 iPad program. This support included both coaching for school leaders and facilitation of processes to distribute leadership for the initiative within the school. The school leader coaching took the form of a dedicated Apple Development Executive (DE), an experienced education professional who partnered with each school from the time the initiative was first introduced, making regular onsite visits to bring leadership tools and recommendations and to serve as a thought partner for leaders as planning and implementation proceeded. School-level support provided by the DE and other members of the support team included structured strategic planning processes and templates, implementation management, coaching on opportunities for teaching and learning presented by the new tools, and support for change management to help prepare for the change that people in various roles at the school would be experiencing.

> Apple strategic planning templates were supreme. I've never had a process work as well as that process.... That whole exercise of really being honest about who we are and getting people on board... We worked for 7 months before we put any devices in kids' hands.
>
> – PK-12 school principal

Principals reported that these activities gave them valuable information and skills (Exhibit 11) and most said that they had implemented new leadership practices and shared them with others (Exhibit 12). The most successful early implementations happened when principals engaged actively during the planning period, recognizing that ConnectED represented a major change in their school that would require sustained, focused attention.

Exhibit 11. School leaders derived high value from leadership development activities

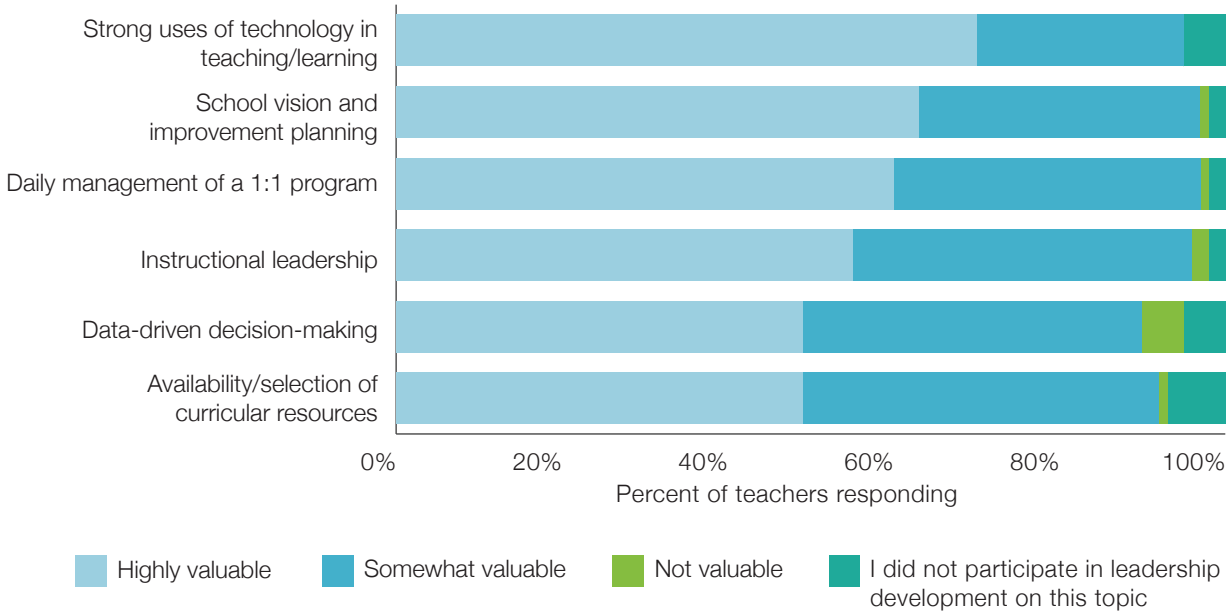
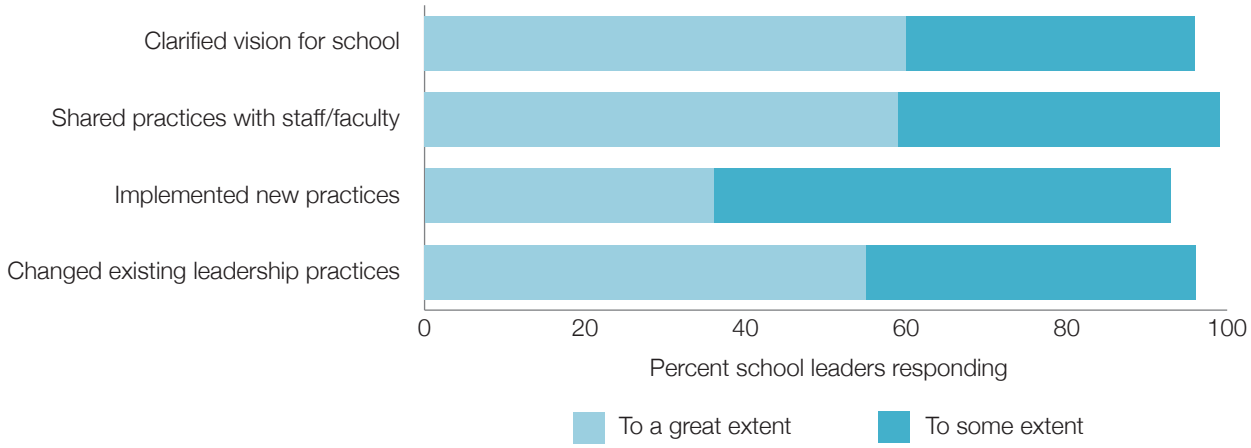


Exhibit 12. Apple leadership support changed leaders' practice



Source: School leader survey 2017. n=80.

Principals have so many responsibilities that it is important to leverage an expanded leadership team to carry a 1:1 technology implementation forward. This kind of distributed leadership also hedged against principal turnover, which could easily derail the implementation of a complex initiative like ConnectED. Apple's model promoted distributed leadership with roles defined in early planning, and included support for "vanguard teams"—clusters of teachers who take responsibility for maintaining the changes brought about by the program moving implementation forward.

Shared vision and clear expectations

Successful Apple and ConnectED schools set shared goals for the program and showed teachers the possibilities for what their use of iPad devices could look like. Having a shared vision for the 1:1 program helped make the connection between student activities with their iPad and student outcomes, and it provided a framework by which schools could evaluate their performance and success. Remembering a valued big-picture goal can also make the day-to-day struggles of early implementation seem worth the effort. The specifics of the goal were less important than the act of defining and implementing a goal that was widely seen as important. In fact, ConnectED schools set a variety of goals, depending on their context.

> You have to take the lead....You have to be able to offer advice or guide them. You just can't say...go use It.
>
> – Elementary principal

Exhibit 13. ConnectED school goals

Expanded access to opportunities	Technology skill building	Achievement	Engagement and confidence	Instructional changes
"I want to see little scientists, little scholars, just walking around and using vocabulary beyond what anyone would think at an inner-city preschool."	"We want to equip them for what the future's like, if we look 20 years down the road."	"I always knew that, if we could have a 1:1 student/iPad ratio, that we can really enhance academic achievement and curriculum integration."	"I wanted our children to become more engaged. I wanted them to be more responsible for their own learning and become independent."	"I'm like the guide on the side. I love that."

In most schools, teachers were using the iPad to some extent every day during early implementation but were still figuring out how best to teach with them. In schools that established and communicated clear expectations for iPad use in the classroom—for example, that teachers should use them every day, or how they should support a particular school-wide norm for context-setting activities at the opening of class—this guidance promoted more consistency during early implementation. A clear and well-communicated vision for the type of instruction that the tools could support, and actionable professional development to support that instruction, also kept teachers from having to work out on their own what iPad use should look like. In addition to professional learning in concert with the school's instructional expectations, Apple provided tools for leaders such as a template to support classroom walkthroughs to promote observation and coaching by instructional leaders.

District buy-in

District support for the initiative varied widely across settings; while application to the program was primarily at the school level, and many individual schools participated, some large districts had up to seven schools receiving support from ConnectED. In some of these cases, district-level support for ConnectED helped schools propel implementation forward.

> [ConnectED] is districtwide. That has made it nice because then we're also able to network with each other and help each other.
>
> – Elementary principal

In turn, supportive districts aided the success of participating schools by providing additional professional development, technical support, program leadership, instructional coaching, and facilitation for technology-related learning. Some districts were also beginning to provide resources for onboarding teachers who joined ConnectED schools after the initiative-sponsored professional learning was nearing its end. One district coordinator noted the desire that APL sessions could also have included district trainers, to better enable them to support and reinforce what the APLs had provided.

Some districts with multiple ConnectED schools also helped schools share experiences and resources related to ConnectED, to avoid isolation and build upon lessons learned. One district staff member said, "If we just had one school, I don't think we'd be nearly as far as we are."

Lessons Learned

The participating schools in the Apple and ConnectED Initiative vary tremendously on many dimensions. While the schools all represent under-resourced contexts, they serve a very diverse set of communities, with different cultures, strengths, and student needs. They also represent a wide range of geographic locations, grade levels, experiences with technology, and goals for teaching and learning. Accordingly, and in keeping with the design of the initiative, these schools and teachers chose very different paths to implementation in the early years of iPad use.

With this degree of diversity, the collective successes and experiences of this set of educators as they adopted a 1:1 iPad initiative can offer important guidance to other districts and schools that are considering a similar path.

Lessons learned include the following:

- **In technology initiatives, initial excitement can deepen into ongoing engagement in learning.** The school visits summarized in this report were early in teachers' and students' journeys with iPad and much enthusiasm could be attributed to novelty. Nevertheless, many classrooms had already instituted practices and routines that parlayed that initial enthusiasm into widespread engagement in academic discussions and assignments.
- **Some affordances of iPad devices seem especially advantageous for English learners and other students with special learning needs.** Multimedia tools, including those built in on the iPad, were in widespread use in many ConnectED classrooms to offer new opportunities to practice language learning or to enrich students' experience with the written word. We saw this contribute to learning in important ways, both for students new to the English language and for other students who were behind on the path to literacy.
- **Even productivity tools can be used in creative ways to push learning environments in new directions.** The professional learning provided by Apple offered examples and practice in the application of built-in apps such as Keynote and Numbers to instruction across subject areas. This allowed teachers to quickly gain comfort with foundational tools and use them in instructionally meaningful ways.

- **High-quality support matters.** The successes that educators achieved in the Apple and ConnectED initiative were firmly in the context of an intensive suite of services that each school received. These included infrastructure upgrades and project management to support the technical rollout as well as dedicated coaching for leaders and teachers to support the human and instructional side of technology adoption. While this level of support is far from typical, particularly in underserved settings, it illustrates a range of needs that must be considered in planning.
- **Technology can provide meaningful instructional change even in the early phases of implementation but building innovative and sustainable technology practices requires purposeful planning and encouragement.** Across a wide range of classrooms, we saw substantial changes in learning environments: the context and process of learning. While the new tools also held significant potential to enrich the substance of students' learning, including potential new opportunities to think critically and to engage more deeply with the subject matter, these changes were less frequently observed in the early years of the initiative. More substantial evolution of students' learning opportunities is likely to require not only more time but also specific models of what's possible and ongoing support for teachers' next steps on their own learning journeys.

This initiative demonstrates the type of instructional innovation that's possible when typical barriers to access are removed; it also reinforces the need for job-embedded professional learning for educators in all roles to help them navigate the many aspects of opportunity and challenges that come with the introduction of 1:1 technology. Future reports in this series will continue to follow the trajectories of Apple and ConnectED schools as they progress to more mature levels of integration and sustainability.

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Menlo Park, CA 94025
+1.650.859.2000
education@sri.com

Washington, D.C.
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