The Apple and ConnectED Initiative: Baseline and Year 2 Findings from Principal, Teacher, and Student Surveys

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Executive Summary

Introduction

Launched in 2014, the Apple and ConnectED initiative represents a substantial corporate investment in the goal of improving opportunities, in learning and in life, for students in some of the most underserved communities in the country. While the potential of technology to help prepare students for the future is widely celebrated, persistent gaps in the frequency and character of its use in low-income schools threaten to exacerbate existing academic inequalities. The initiative seeks to address this issue by bringing not just technology but also comprehensive support that includes planning, professional learning, and ongoing guidance to 114 underserved schools across the nation. The goal is to promote more personalized and student-centered educational experiences that support critical thinking and conceptual understanding and, in turn, improve learning outcomes for students.

This report is the first in a series from a rigorous evaluation of the Apple and ConnectED initiative conducted by SRI International (SRI). The full study combines surveys, case studies, achievement data, and examination of learning opportunities to offer a well-rounded picture of what it takes to leverage technology to dramatically improve learning opportunities, particularly in schools and communities that have had limited access to equitable opportunities in the past. The current report summarizes results from surveys of teachers, school leaders, and students in the first two years of the initiative.

The Apple and ConnectED initiative offers an unparalleled testbed for such a study. The initiative required that schools have a minimum of 96% students who quality for free and reduced lunch in order to apply, ensuring the initiative reached schools serving economically disadvantaged populations; school selection was also based on demonstration of strong leadership capacity and a compelling school vision. Apple sought to leverage insights from decades of experience bringing technology to classrooms to design a suite of offerings that would give the selected schools the support they needed to reach their goals for the students. This comprehensive initiative includes devices (including an iPad for every student and an iPad and MacBook for every teacher); infrastructure upgrades; a dedicated team to provide sustained support for leadership development, teacher professional learning, technology and project management; and access to an ecosystem of apps and other digital learning resources. Recognizing the diversity of the participating schools, the initiative customized both implementation

timelines and support to meet the unique needs of each school setting.

Overall, a total of 114 schools are participating in the initiative, including 72% elementary, 12% middle, 10% high schools, and 6% that span these grade ranges. These schools are geographically and demographically diverse and serve a wide range of disadvantaged communities. Compared with other high-poverty schools, these schools experienced roughly similar rates of principal turnover (approximately 41% over two years), but they had higher-than-average numbers of new teachers (approximately 22% of teachers had less than 4 years of experience). Technology access was often limited within the communities served by these schools, with 55% of principals estimating in 2015 that at least 75% of their students lacked home access to the internet.

This report focuses on data from principal, teacher, and student surveys. To date, two rounds of principal surveys (spring 2015, spring 2017) and teacher surveys (fall 2015, spring 2017) have been conducted in 101 participating schools. In addition, 13 schools participated in a student survey (winter of 2016-17 school year). Because schools received their technology according to their readiness rather than all at once, at the time of the spring 2017 teacher and principal surveys participating schools had been using their Apple resources between 5 and 17 months; at the time of the student survey, between 3 and 17 months. This variation in time spent with the devices is important, as the findings reported here are averaged across this range of schools and thus reflect different amounts of time and maturity for the technology integration.

Early Findings

Survey reports demonstrate increases in technology use and some initial evidence of more student-centered pedagogies as the Apple and ConnectED initiative got underway. The results summarized below suggest that the early path of the initiative is consistent with the typical trajectory of change for technology-related initiatives, in terms of the types of changes that tend to emerge first. The initiative is thus well positioned to realize its intended goals in these high-poverty settings.

Changes in Technology Use

Apple provided technology infrastructure upgrades and devices for all principals, teachers, and students, along with a sustained program of coaching and consulting. The influx of technology was an important, but by no means singular, component of the initiative.

Teachers began using technology more frequently than at baseline, especially for differentiating instruction. By spring 2017, teachers were using technology more frequently, for a greater portion of class time each day, and in more varied ways, than they had been at baseline. The largest increases in teacher technology use were for activities related to monitoring students' learning and adapting instruction to individual students' needs, highlighting the value of technology for offering insight into student progress and understanding.

Teachers also increased their use of technology in searching for instructional materials and presenting information to students, although these activities were already common at baseline.

Students are using technology more frequently and for varied learning activities. Expanding access and increasing student use of technology in the context of high-quality learning activities are important first steps toward the larger goal of digital equity. Students indeed increased their use of technology, with the percentage of teachers reporting daily student use in their classroom growing from 31% in 2015 to 75% in 2017. The most common activities reported by students were finding information (e.g., 70% of student survey respondents looked up information at least weekly) and creating products such as presentations. Further, 75% of teachers reported that their students used learning games at least weekly, with students at elementary grades playing more learning games than older students.

Teachers whose students tend to increase technology use have certain shared characteristics, and in turn report using technology in more innovative ways. Of the teachers whose students used technology infrequently prior to the initiative, a few striking differences exist between those whose students' use grew substantially during the initiative and those who did not. The teachers whose

students became more active users of technology tended to use more technology themselves and had somewhat more positive initial attitudes toward technology. In contrast, teachers whose students used technology less frequently reported less initial confidence and more challenges managing workflow and finding appropriate digital content. Teachers whose students increased their use of technology also reported higher rates of using technology in innovative ways—that is, for activities that would not have been possible without it. These findings suggest teacher comfort and confidence with educational technology influences uptake and instructional innovation. Varying levels of support are required to meet teachers where they are and support them in meaningful technology integration.

Perceived challenges to using technology in instruction decreased greatly compared to baseline. Prior to the Apple and ConnectED initiative, teachers in these high-poverty schools faced a number of barriers to implementing technology in the classroom, each of which diminished drastically as the initiative got underway. The initiative appears to have successfully resolved the issue of adequate and reliable technology access for students: In 2015, many teachers had major concerns about internet reliability or malfunctioning devices (44% and 40%, respectively). By 2017, the number of teachers with similar concerns dropped precipitously to just 15% and 6% respectively. In addition, fewer teachers believed that insufficient instructional time was a major barrier in 2017 than in 2015 (15% vs 35%), suggesting that when access becomes smoother, technology use demands less instructional time than it might otherwise. An important concern that remained constant over time across principals, teachers, and students was the issue of student behavior associated with using technology, confirming that school-wide technology policy and classroom management strategies need attention in order for technology integration to be productive.

Deeper Learning Opportunities for Students

The Apple and ConnectED initiative is predicated on the belief that instruction supported by digital resources can help students to develop the skills and mindsets needed to learn academic content more deeply and thrive in the 21st Century. The initiative defines "deeper learning" in five dimensions: teamwork; communication and creation; personalization of learning; critical thinking; and real-world engagement. Of these, the first four were included on both 2015 and 2017 surveys; real-world engagement was added to the survey in 2017 based on evolving definitions.

The overall frequency of deeper learning opportunities increased slightly over time. All four deeper learning dimensions that were measured at both baseline (2015) and the spring of 2017 increased in frequency. These changes were relatively small in magnitude, but they are nonetheless statistically significant. The greatest gains

were seen in personalized learning and correlated with technology use: teachers who used technology more frequently also reported offering more personalized learning opportunities for students. The smallest overall gains were in communication and creation. At a basic level, students were more often using newly available tools such as iMovie and GarageBand to create products that communicated their ideas. However, most of these opportunities for communication and creation did not reflect advanced requirements such as attending to the needs of an audience or applying principles of design. In general, first steps toward deeper learning opportunities were evident in classrooms; at the same time, more support may be needed for teachers to craft increasingly strong opportunities for critical thinking, teamwork, and other elements of deeper learning.

Elementary school teachers were responsible for most of the increase in deeper learning opportunities. Elementary teachers increased the frequency of deeper learning opportunities for teamwork, communication and creation, personalization of learning, and critical thinking in their classrooms between 2015 and 2017. High school teachers, in contrast, stayed at the same levels across all deeper learning dimensions, and middle school teachers increased opportunities for personalized learning but not for collaboration, critical thinking, or communication and creation. This variation may be partly explained by the nature of learning opportunities that can support test proficiency at each level. For example, elementary schools commonly used adaptive learning games (which drove the increase in personalized learning across levels). These learning games focused on reading and mathematics and were regarded as helpful for basic skills development and therefore enhanced test performance. In contrast, at the high school level, teachers reported struggling to introduce digital learning activities without detracting from lessons they believed would more directly support test performance.

Apple Support for Technology Integration

Among the members of the dedicated support team that came as part of the Apple and ConnectED initiative, each school had an Apple Development Executive (DE) who worked closely with the school principal around strategic planning and instructional leadership, and a designated Apple Professional Learning Specialist (APL Specialist) who devoted a total of 17 days onsite working with teachers during the first year of implementation. All Apple DEs and APL Specialists have extensive backgrounds in education, including education training and classroom experience. Survey questions were designed to help assess how this support aided leadership development and teacher professional learning.

Teachers described the support they received from Apple Professional Learning Specialists (APL Specialists) as both distinct in nature and more impactful than other professional development (PD) they had received. In contrast to PD they had received prior to the initiative, teachers reported that the professional learning from their APL Specialist (including trainings and informal interactions) focused more directly on their needs; was more hands-on and less lecture-based; and had more follow-up than PD from other sources. They indicated that support from their APL Specialist was more impactful than other PD in the degree to which they used new lessons in their teaching and improved their comfort in allowing students to take initiative. Over 90% of teachers agreed that the professional learning bolstered their confidence around using technology for teaching and learning and gave them concrete skills for selecting digital content and using technology to support student learning.

Principals were also enthusiastic about the leadership development they received from Apple. Of the 82 principals responding to the survey, more than 90% reported that working with their DE was valuable for a range of leadership activities, from clarifying a vision for the school that specified what it would mean to integrate technology into learning, to gaining and implementing new ideas for leadership, to supporting the practical management of implementing a school-wide technology initiative. Perhaps not surprisingly, existing practices proved most difficult to change, with only 35% of principals stating that the Apple leadership support had changed existing leadership practices to a great extent.

Principal and Teacher Attitudes and Beliefs

Beliefs about pedagogy and educational technology form a spectrum, from a more curriculum-focused orientation to a more student-centered orientation, and from skepticism about educational technology to enthusiasm. While a curriculum-focused orientation emphasizes the role of the teacher in delivering established content to students, a student-centered orientation focuses on engaging students in critical thinking and sense-making in a manner responsive to the needs and abilities of the students themselves. For teachers to make a transition toward more student-centered pedagogies and deeper technology integration, beliefs that support these transitions are important.

Teachers' pedagogical beliefs shifted slightly toward student-centered pedagogy, while principals' beliefs remained unchanged. Overall, participating teachers started out with pedagogical beliefs that trended slightly toward a student-centered orientation (i.e., emphasizing personalization and students' sense-making and engagement over more structured content and classroom management), and they moved a bit more in this direction over the course of the initiative. The change was statistically significant, implying that some teachers are becoming more open to the student-centered orientation the initiative seeks to promote and that is supported by research (NRC, 2000; Sawyer, 2006). Principals started out with a stronger student-centered orientation than teachers and that did not change over this timeframe.

Teachers' views of educational technology remained strongly positive overall, but some—especially high school teachers—expressed new reservations about educational technology. Participating teachers had strongly positive views of educational technology at the outset: they generally believed that educational technology could support student learning and had few drawbacks in terms of added work or distractions. By 2017, these beliefs remained fairly strong, though they dipped somewhat from the baseline. Consistent with prior findings about differences across schooling levels, these dips in enthusiasm were more pronounced for high school teachers than for elementary or middle school teachers.

Outcomes for Teachers and Students

The Apple and ConnectED initiative aims to meaningfully improve learning experiences for some of the nation's most underserved students. Beyond traditional measures of academic success, the hope is that the initiative will improve the school experience for these students, making learning more relevant to their lives, offering more opportunities for students to express themselves, and building their skills for work and life.

Principals reported that the Apple and ConnectED initiative benefited their schools and teachers. By 2017, most principals agreed that the initiative was showing strongly positive outcomes in terms of technology access, teacher confidence around teaching with technology, and student engagement and technology skills, with relatively strong growth in reports of students' 21st century skills as well. However, principals reported that the initiative had not yet had as much impact on teacher pedagogy and traditional academic outcomes such as school accountability metrics. These reports align with the expected change trajectory, which anticipates that technology use and confidence emerge first as teachers begin incorporating technology into their work, and that more traditional measures of academic success are slower to change.

Teachers reported that the initiative supported student engagement and skills. Teachers agreed almost unanimously (98%) that the initiative has been valuable for their schools. Specifically, teachers reported that the initiative benefited students in terms of engagement, learning, and preparation for future success. Regarding engagement, teacher-reported levels of student engagement grew slightly from 2015 to 2017; the change was statistically significant. In particular, basic aspects of engagement (e.g., paying attention) started high and remained high, while deeper forms of engagement (e.g., going beyond expectations) increased over baseline measures. These signs of deeper engagement are important because they suggest that students are not merely on task, but that they are becoming more invested in their work. Regarding learning, teachers reported small but statistically higher levels of student proficiency across most deeper-learning-related skills (e.g., figuring out something new; working collaboratively; creating strong products) since the initiative began. The ability

to solve open-ended problems remained stable over time. These findings also align with what we know about the technology use and the deeper learning opportunities that students are experiencing: classroom experiences at this early stage in the initiative have typically featured the use of technology to create products and collaborate with peers. Learning activities that demand open-ended problem solving and critical thinking are in evidence in some classrooms, but these opportunities are not yet common.

Students were enthusiastic about their experiences with the Apple and ConnectED initiative, with positive reviews about how the iPad impacted their engagement and learning at school. Students were very positive about their overall experience with iPads, with elementary students (like their teachers) showing even stronger enthusiasm for the initiative than middle and high-school students. Students were also very positive about how the iPads have changed learning, with majorities reporting the technology helped them to stay engaged, collaborate, and learn. Many students also believed that iPads helped teachers know them better, both because they gave students more opportunities to express themselves and their personal interests and because the technology gave teachers more opportunities to see how their students were doing academically. These student reports mirror those from teachers, who indicated that the iPad enables them to personalize their instruction more than they could previously.

Conclusion

The scale and the comprehensive design of the Apple and ConnectED initiative, along with its focus on schools serving high-poverty communities, make it noteworthy among technology integration efforts. It goes far beyond many technology initiatives to include in-depth strategic planning, ongoing technology support, and personalized, professional learning for school leaders and teachers. Further, it abandons a one-size-fits-all approach in favor of supporting each school on its own unique journey to improve student experiences and outcomes. These features make the initiative particularly fruitful for research as well, providing an opportunity to study the interplay of different design elements and how they influence implementation paths and ultimate success. Early findings from the research suggest that these design features have helped principals and teachers take important first steps toward achieving their goals.

The changes documented thus far, from broad increases in technology use to deeper student engagement to more frequent opportunities for certain types of deeper learning, represent significant advances toward the types of teaching and learning envisioned by Apple and by participating schools. While an influx of technology of this magnitude would be expected to promote excitement and new opportunities, immediate widespread use is by no means guaranteed, and these initial advances suggest the strength of the initiative's comprehensive support model and the power of personal support for teachers as they navigate what is often an overwhelming process of change.

At the same time, these changes follow a relatively common trajectory for educational initiatives: technology use and deeper learning have increased first in ways that take advantage of tools and practices that are ripe for implementation right out of the gate, laying important groundwork for deeper changes to teaching and learning that might emerge. The initiative is now entering a new stage, transitioning to a more explicit focus on the deep integration of technology to support critical thinking and conceptual understanding, and evolving new ways to help schools to sustain their positive trajectory amidst inevitable turnover of key staff and other unavoidable interruptions.

For others who may be considering technology integration initiatives, the Apple and ConnectED initiative offers both lessons and new questions to pursue. The initiative highlights the importance of comprehensive and personalized support for technology integration and instructional change. As these implementations mature, on their own paths and within their own local settings, they can continue to instantiate models of what is possible within these diverse contexts and to inform important questions

about the most essential forms of support, the variety of paths to meaningful change, and mechanisms for promoting sustainability and scalability beyond initial investments.

In this next phase of the initiative, schools face the challenge of deepening the changes they have made thus far: using technology in ways that allow students to visualize complex concepts, connect with the world around them, and build their skills for the future. With these continued advances, schools have the opportunity to make an increasingly profound difference in the education and lives of their students.

The Apple and ConnectED Initiative: Baseline and Year 2 Findings from Principal, Teacher, and Student Surveys

Full Report

Introduction

Through its Apple and ConnectED initiative, Apple has undertaken an ambitious mission to improve learning opportunities for students in America's most underserved communities. For the 114 participating schools, Apple's contribution is much more than the well-publicized iPad for every student and iPad/MacBook for every teacher. Instead, Apple is building on its decades of experience with technology in schools to provide a full suite of resources and support that experience has shown is key to successful technology-supported learning.

Apple is taking this comprehensive approach with the recognition that providing technology in underserved schools is not sufficient to move the needle toward the goals of equitable learning opportunities and preparation for the future workplace. In fact, due in large part to federal programs such as e-Rate and Title I funding, gaps in technology access between high- and low-poverty schools have narrowed sharply (Warschauer & Matuchniak, 2010). Nevertheless, gaps persist in the frequency and character of technology uses in the classroom. Computers are used more often for drill-and-practice and basic content acquisition in low-income schools, and for tasks like extended writing and analysis in higher-income schools. This trend has endured over time (Becker, 2000; Gray, Thomas & Lewis, 2010; Warschauer & Matuchniak, 2010; Reich & Ito, 2017), and suggests there is more opportunity to leverage technology for 21st-century skill development in better-resourced schools.

Given the initiative's scale and the variety of contexts in which it operates, it creates an unparalleled testbed for understanding ways to dramatically improve learning opportunities using technology, particularly in underserved communities. This report is part of a rigorous program of research on the initiative, conducted by SRI International, to study implementation and outcomes for students, teachers, classrooms, and communities across participating schools. This report, the first in a series, will focus on the results of teacher, principal, and student surveys over the first two years of the initiative. Future reporting will describe the various strands of research, triangulate findings, and discuss themes from the work as a whole.

Background

About the Initiative

The Apple and ConnectED initiative launched in 2014. Program leaders sought to support schools that (a) serve high-needs students, and (b) have the capacity and conditions to benefit from the initiative. In order to apply, 96% or more of the 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 were selected to participate, representing a range of community types from the inner city to rural towns with high migrant populations to Native American communities.

Apple and SRI worked together to create a unique approach (see Appendix) that includes a recognition that successful technology implementation requires: personalized professional support; encouragement and support for each school to follow its own path and pace rather than a one-size-fits-all model for change; and defined elements of school leadership and infrastructure readiness for technology integration. Desired outcomes for students are the development of "deeper learning" skills (also known as 21st-century skills) and engagement as well as gains in more traditional academic measures. For teachers, the approach is designed to encourage student-centered pedagogy, optimism about students' potential and increased commitment to the teaching profession. In addition, the approach is intended to increase leadership skill and commitment in administrators and provide community support for student engagement and success.

For each of the schools, the initiative offers a package of tools, resources, and support informed by early research that demonstrated "meaningful use of technology in schools… goes far beyond just dropping technology into classrooms" (Dwyer, 1994). Over the first two years of the initiative[1] in each school, Apple's support included:

- **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:** One of the unique aspects of the Apple and

1 After the first two years, Apple's support continues but follows a different model to promote increased school-based ownership and sustainability.

ConnectED initiative is the intensity of support provided for each school. The team includes: 1) an Apple DE to support school leadership in visioning, instructional leadership, and change management; 2) an Apple APL Specialist who is onsite at the school for a total of 17 days providing 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; role described below). The DEs and APL Specialists are all education professionals with experience as teachers and/or administrators.

- **Tech support:** Schools have access to a dedicated PE and to AppleCare hardware and software support as needed. This technology support includes 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 have access to a wide range of apps and educational resources available from Apple's App Store, iBooks Store, and iTunes.

The evolution and improvement of learning opportunities is a process that takes place gradually over an extended period of time (Apple Computer, Inc., 1995; Baker, Gearhart & Herman, 1990: Dwyer, Ringstaff, & Sandholtz, 1991; Sandholtz, Ringstaff, & Dwyer, 1997). While excitement typically accompanies an initial rollout of this magnitude, and teaching and learning may take on a different and more engaged character with the integration of technology, the evolution of teacher beliefs and deeper changes to teaching and learning may roll out more slowly (Dwyer, Ringstaff & Sandholtz, 1991; Harper & Milman, 2016), and ultimate outcomes such as improved test scores are likely to take several years to realize (Baker, Gearhart & Herman, 1990; Drayton et al., 2010; Suhr et al., 2010; Texas Center for Education Research, 2008).

The initiative recognizes two distinct models for adding technology to influence classroom learning environments, each represented on a different scale. The first involves the **depth of technology integration**, as defined by the degree to which the technology use changes the learning opportunities offered to students (rather than changing only the way the learning activity is conducted). In this report, we use the term **innovation** to represent fundamentally new learning opportunities that would not be available without the use of the tools. The second comprises **deeper learning opportunities** that build a particular set of skills (such as critical thinking and teamwork) important to students' future successes. In this report, we use the term **advanced** (in contrast with **basic**) to describe particularly strong opportunities for deeper learning. Together, innovative technology use and advanced deeper learning opportunities include practices and experiences that

achieve the kind of teaching and learning optimally envisioned in the initiative.

Finally, we use the term **student-centered** to describe teaching and learning that considers students' needs as a primary driving force for instruction, takes the abilities of the individuals in the class into account, gives students an active role in learning, and helps students gain deep conceptual understanding and develop enduring skills. Certainly, there is substantial overlap between student-centered instruction and deeper learning.

About the Research

This report is part of a comprehensive 6-year independent research study, conducted by SRI International, to investigate both implementation and outcomes of the Apple and ConnectED initiative. The study includes multiple complementary components: surveys of school leaders, teachers, and students; case studies of selected schools, with supplemental longitudinal interviews of a subset of teachers; the investigation of learning opportunities through the lens of lessons and student work samples (LOSW); and a study of achievement outcomes. School leader and teacher surveys are designed for breadth, capturing data from 101 of the 114 participating schools, while case studies, student surveys and LOSW focus on smaller samples of 11-15 schools in order to paint a rich picture of the process and demonstrate outcomes of technology-supported instructional change.

This report draws on principal, teacher, and student surveys in the first two years of the initiative. The data come from two rounds of school leader surveys (spring 2015, spring 2017) and teacher surveys (fall 2015, spring 2017) to offer an analysis of change over time in the first two years of the initiative. In addition, 13 schools participated in a student survey in winter of 2016-17, adding a glimpse of the student experience early in the rollout.

We initially surveyed school leaders in spring 2015 (before schools had received any devices) and teachers in fall 2015. This is the baseline, describing schools and classrooms before starting the initiative (Table 1). Because some schools had already received devices by the time of the teacher survey (fall 2015), all questions that pertained to teaching and learning (including use of technology) were framed to ask about spring 2015, before devices were received. The second round of the school leader and teacher surveys provide a follow-up, conducted in spring 2017. At that time, all students had their iPad devices for at least 5 months (and at most, 17 months).[2] This variation in time spent with the devices is important, because our findings are averaged across this range of schools and reflect different amounts of time and maturity for the technology integration and different dosages of professional learning. The school leader and teacher surveys aimed to gather information about: characteristics of the schools and classrooms; views regarding teaching and learning, educational technology, and the initiative;

2 Consistent with the initiative design, implementation timelines at the schools were intentionally varied according to the readiness of each school, with students receiving their devices anywhere between May 2015 and December 2016.

Table 1. Apple and ConnectED Research survey basics

Survey type	School Leader		Teacher		Student
Administration year	2014-15	2016-17	2015-16	2016-17	2016-17
Survey timing	Apr-Jun	Mar-Apr	Oct-Feb	Mar-Apr	Nov-Mar
Number of months students had iPads at the time of the survey*	0	5-17 months	0-6.5 months**	5-17 months	3-17 months, with all but one school having it for 14 months or less
Number of respondents (response rate)	97 (96%)	90 (79%)	2610 (81%)	2432 (76%)	1828 (71%/87%)***
Number of schools represented	97	89	102	101	13
Number of schools with 75%+ Teacher Survey response rate	N/A	N/A	79	71	12
Target sample	All school leaders		All teachers		Grades 4, 5, 7, 8, 10, 11

** The number of months was calculated as the time elapsed between student iPad deployment date and the survey date, excluding 2.5 months per summer.*

*** On many topics (including teaching, learning and educational technology use), teachers were asked to report on spring 2015, before any students had received iPads.*

**** The student survey was administered in six elementary schools, two middle schools, three high schools, one K-12 school and one 8-12 school. Excluding one middle school that required active parental consent for students to participate in the survey, the average response rate was 87%.*

pedagogical practices and technology use in the classroom (teacher survey only); and professional development experiences.

For student surveys, we purposely selected 13 schools that encompass the differences reflective of the participating schools overall. The surveys were administered to students in elementary school (grades 4, 5), middle school (grades 7, 8), and high school (grades 10, 11) and aimed to gather information about students' learning and engagement in school, how they used their devices for learning in school and what they thought of about iPad-supported learning experiences, their technology use at home, and future plans. Students responded to the survey on their iPad, after having used them for 3 to 17 months, depending on the school.

The teacher survey captured information about school-level factors (e.g., school climate, leadership, etc.) as well as classroom-level factors (e.g., teacher practices, use of technology, student experiences and outcomes). For the classroom-level factors, we instructed teachers with multiple classes (typically middle and high school teachers) to select a particular "target class" as the basis for their responses.

For teacher survey analysis, we included some criteria to ensure that (a) teachers remained anonymous, and (b) a minority of teachers at a school did not disproportionately influence the results. These criteria were applied to school-level analyses, that is, analyses in which we averaged teacher responses at each school, and then analyzed or compared results across schools. For these analyses, we did not include any schools with fewer than 75% of teachers responding to the survey. Further, we did not include data for any individual survey items from schools with fewer than five teachers responding to that particular item.

About the Apple and ConnectED Initiative Participants

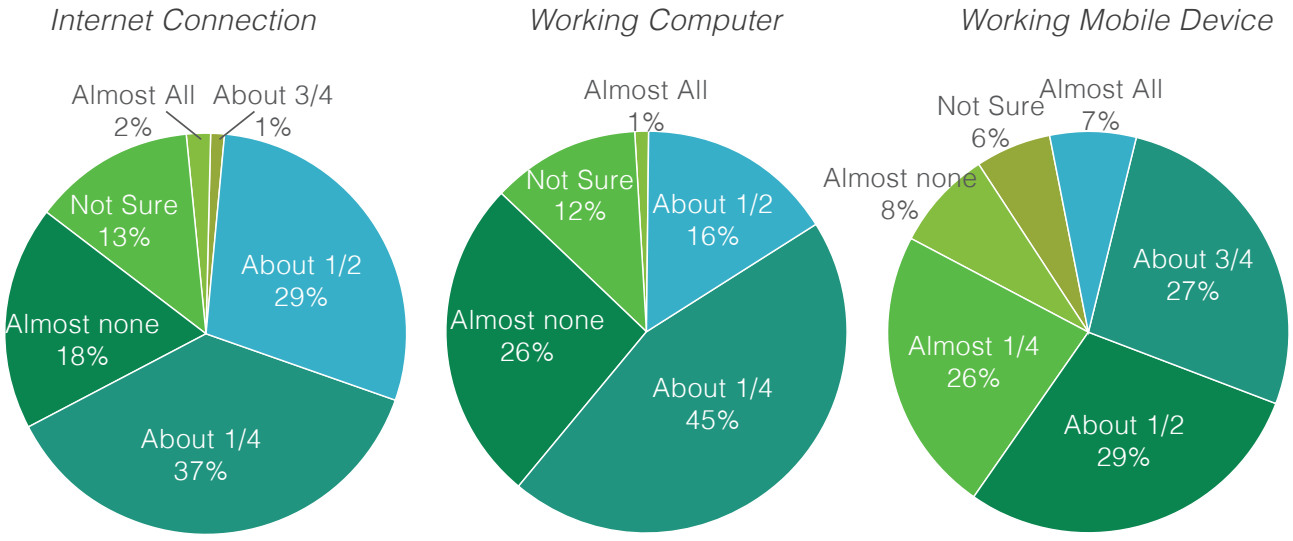
Given the target populations and participation criteria, schools participating in the Apple and ConnectED initiative were geographically and demographically diverse (Table 2).

Additionally, technology access was sometimes limited within the communities served by these schools. At the outset, school leaders estimated that many of their students had no access to the internet, a working computer or working mobile devices at home (Figure 1). In contrast, the student survey suggested that over three-quarters of students had at least some experience with tablets prior to the initiative (Figure 2).

Table 2: Characteristics of participating schools

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

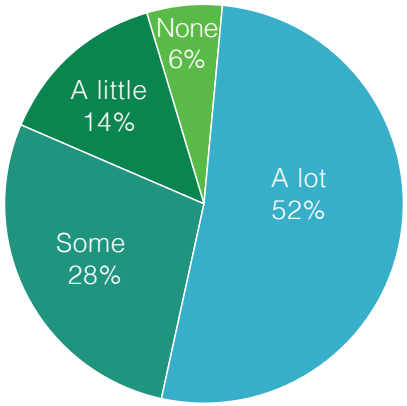
Figure 1. School leader estimates of students' technology access at home in 2015



Source: School Leader Survey 2015. n=98.

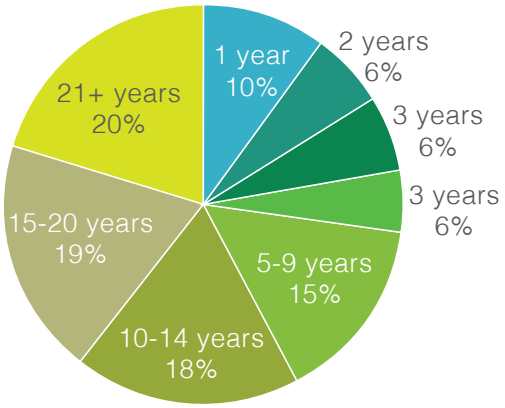
Given the emphasis on school leadership capacity in the selection process, most participating schools were initially led by experienced principals. In spring 2015, when the first schools were beginning to receive their devices, 88% of school leaders had five or more years of experience in their profession, and 82% had three or more years of experience as a principal at their current school. However, by fall 2015, 23% percent of the school leaders who had applied for the initiative had left their positions; by spring 2017 that number grew to 41%. This turnover poses a threat to any initiative seeking to impact schools by enhancing school principals' skills, though it falls within estimates for the national average leadership turnover rate, which is roughly 15-30% annually, and higher at high-poverty schools (Goldring & Taie, 2014; Béteille, Kalogrides & Loeb, 2012). At the same time, participating schools tended to have higher-than-average proportions of new teachers, even when compared with other high-poverty schools (Goldring, Taie, & Riddles, 2014) (Figure 3).

Figure 2. Students' experience with tablets prior to the Apple and ConnectED initiative



Source: Student Survey 2016-17.

Figure 3. Teaching experience of participating teachers



Years of Teaching Experience	Apple and ConnectED Schools	High Poverty Schools*
<4	22%	14%
4-9	20%	32%
10-14	18%	21%
15+	39%	34%

*Source: Teacher survey 2017; *NCES School and Staffing Survey Teacher Follow-up Survey 2012-13 (Goldring et al, 2014).*

Early Findings From the Survey Research

Here we summarize findings from the survey research and explore what is really happening in schools and classrooms in terms of implications for the initiative and the broader education community. We begin by looking at two principle features of classroom practice: use of technology and opportunities for deeper learning. For each, we examine patterns of practice and how they have changed over the course of the initiative thus far. Next, we take a step back to examine the resources and other support Apple has provided to teachers and leaders to support those changes in the classroom. Since participation in professional learning (and participation in the initiative itself) can influence beliefs and attitudes, we consider participants' beliefs about educational technology and pedagogical approaches in education, and discuss how those have changed since the initiative began. Finally, we look at reported outcomes to date for schools, teachers, and especially students. When describing student outcomes, we focus primarily on outcomes such as engagement, 21st-century skills, and preparation for future success.

Changes in Technology Use

The survey responses clearly show changes in technology use from the baseline in spring 2015 to the early stages of the initiative in spring 2017, when students had iPad devices anywhere between 5 and 17 months. The survey data suggest that overall, two years into the initiative, more students had access to technology in their classrooms, and participating teachers and students used technology more frequently, for longer periods of time, and—at least for some teachers—in more innovative ways. While this is not a surprising outcome for an initiative that provided a strong influx of technology, it is also not automatic. New technology has gone unused or been under-utilized in other programs (Bebell & Kay, 2010; Cuban, 2001; Ertmer & Ottenbriet-Leftwich, 2013; Shapley et al., 2010). Importantly, teacher and leader concerns about 1:1 technology adoption decreased drastically between the two surveys, suggesting that once the initiative was underway and teachers began using the technology in their classrooms, some of the barriers they faced prior to the initiative were alleviated.

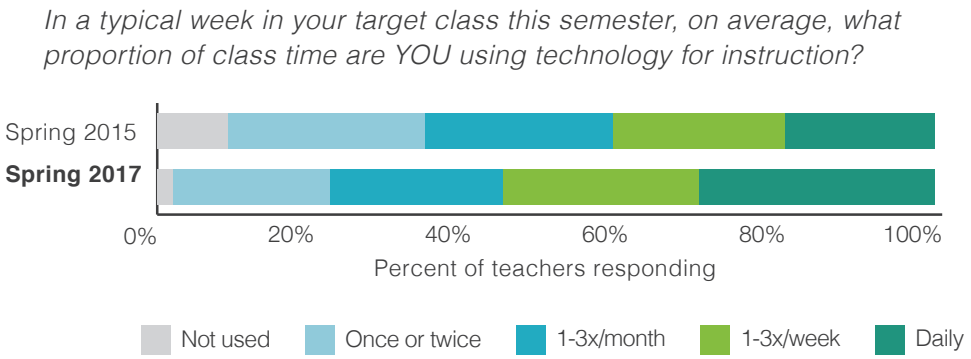
Teachers are using technology more frequently, especially for differentiating instruction

After implementation got underway, teachers began using technology in their classrooms more frequently and in a greater variety of

ways than they had before. Figure 4 (below) shows that in 2017 teachers used technology themselves for a greater portion of class time than they had previously.

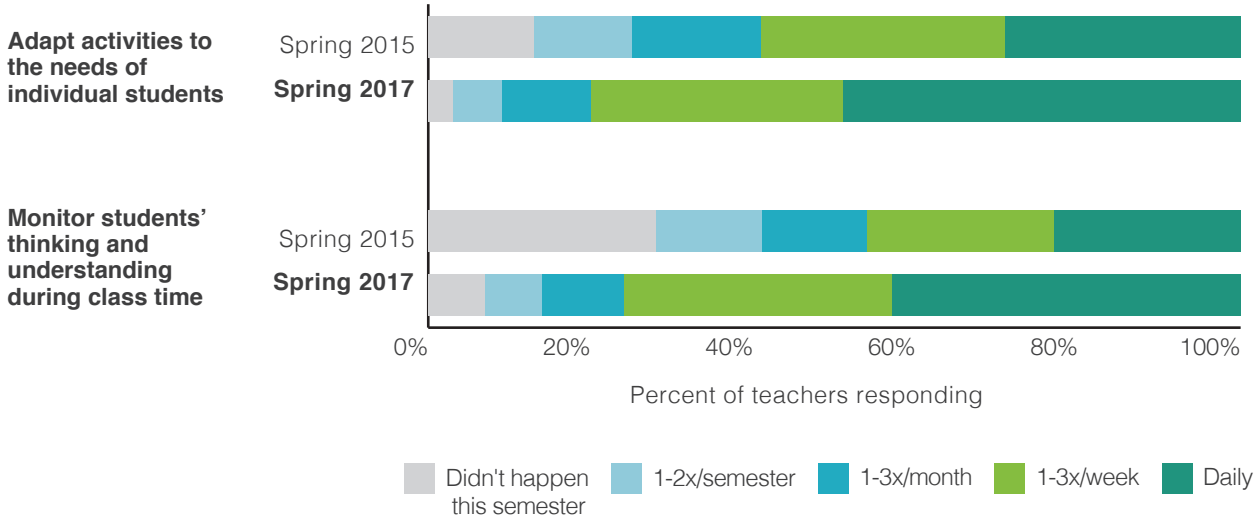
In terms of ***how*** teachers were using technology, the two most noticeable increases had to do with differentiating instruction (Figure 5). The proportion of teachers who used technology to monitor students' activity during class at least weekly increased from 46% to 76%, while weekly-or-more-frequent use of technology to adapt activities to individual students' needs increased from 59% to 80%. While it is certainly possible to monitor students and adapt instruction without technology, technology can make it easier for teachers to gain insight into student progress in near real time and to analyze student

Figure 4. Proportion of time teachers used technology in their target class, in a typical week



Source: Teacher survey 2015 & 2017. n=1153. Figure only includes responses from teachers who participated in both surveys. The distribution of responses that include all responses from each survey looks similar.

Figure 5. Teachers' use of technology, spring 2015 vs. spring 2017



Source: Teacher survey 2015, 2017. n=1126-1130.

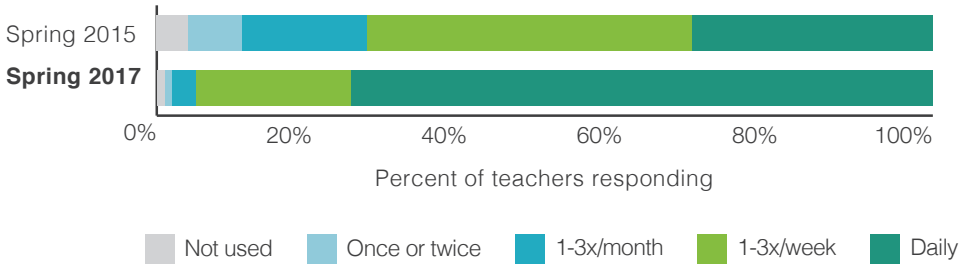
performance to identify particular areas of difficulty. Separate from differentiating instruction, teachers also increased their use of technology in searching for instructional materials and presenting information to students, though most teachers were already doing these activities at baseline.

Students are using technology more frequently and for varied learning activities

The Apple and ConnectED initiative seeks to promote digital equity, a goal predicated on expanding access and increasing student use of technology in the context of high-quality learning activities. To date, students have indeed increased both their frequency of use and the portion of class time spent using technology. The figures below illustrate these trends, showing the percentage of teachers who reported certain types of use in 2015 (on top) and how that shifted in 2017 (on bottom). Daily student use of technology increased from 31% in 2015 to 75% in 2017. Similarly, the portion of teachers reporting students used technology for three-quarters of class time or more increased from 18% in 2015 to 44% in 2017. Not surprisingly, this trend was driven by teachers whose within-classroom access was

Figure 6. Frequency of student technology use in class

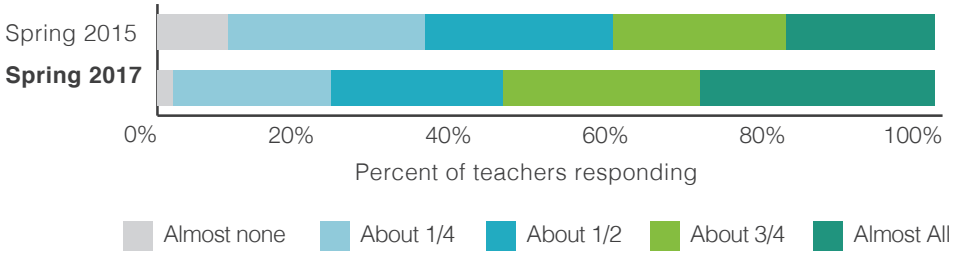
Thinking about your target class in spring 2015, how often did your students use technology for learning…?



Source: Teacher survey 2015, 2017.

Figure 7. Portion of class time students used technology

In a typical week in your target class this semester, on average, what proportion of class time are ALL STUDENTS using technology for instruction?



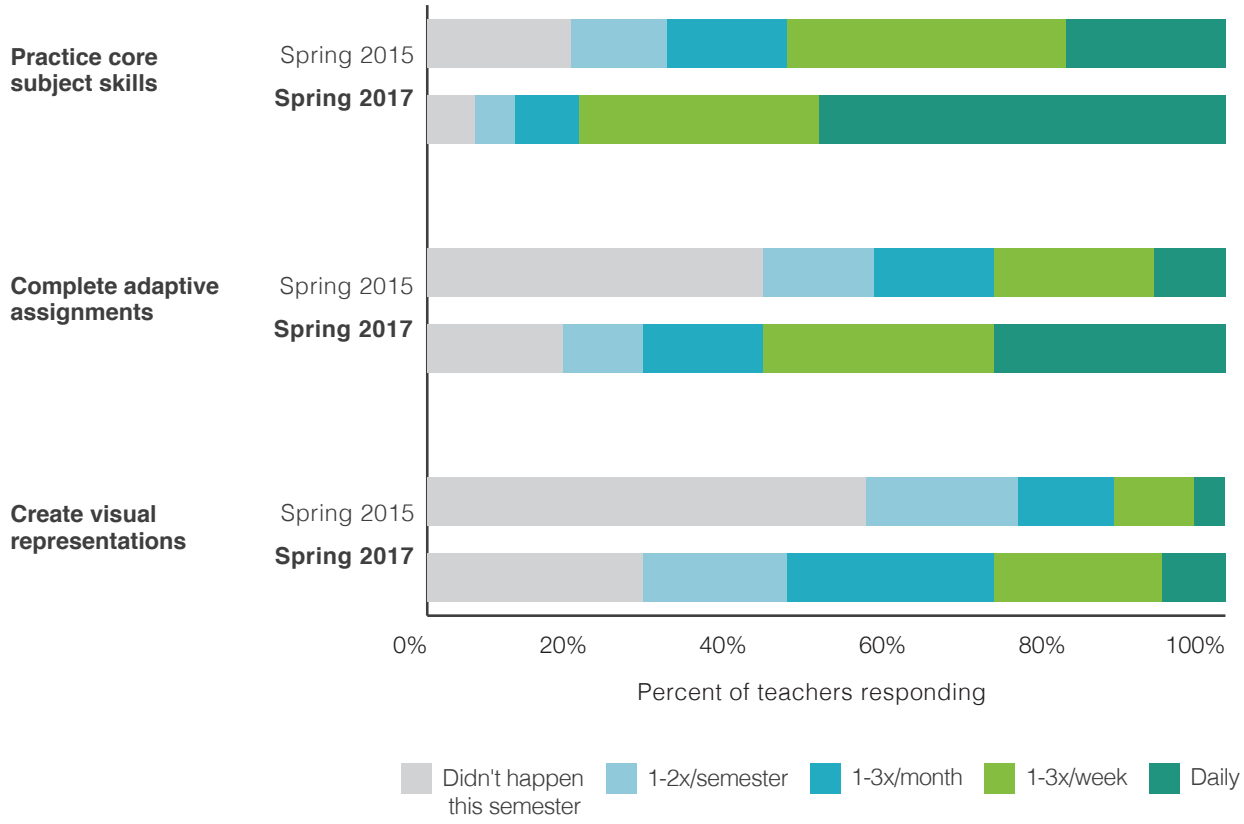
Source: Teacher survey 2015, 2017; n=1051.

less than 1:1 prior to the initiative, as there were more opportunities for use when all students in the class had access to the same tools.

There were some small but noteworthy differences across grade levels with respect to how much students used technology for learning. For example, elementary school students used technology most frequently with 81% of teachers reporting daily use, compared with 58% of middle and high-school teachers reporting daily use. With respect to changes in technology use over time, usage increased fairly consistently across all schooling levels. However, the frequency of student technology use in mathematics increased more in elementary schools than in middle and high schools. From spring 2015 to spring 2017, daily use of technology in elementary school math classes rose from 27% to 72%, while in middle and high schools it increased from 26% to just 48%. This more frequent use of technology for math in elementary school likely reflects use of math learning games.

Of course, what matters for learning is not simply how much students are using technology, but also in what ways they are using technology. The survey results showed students used technology for varied activities, from practicing core subject skills to creating visual representations (Figure 8). According to both

Figure 8. How students used technology in 2015 and 2017



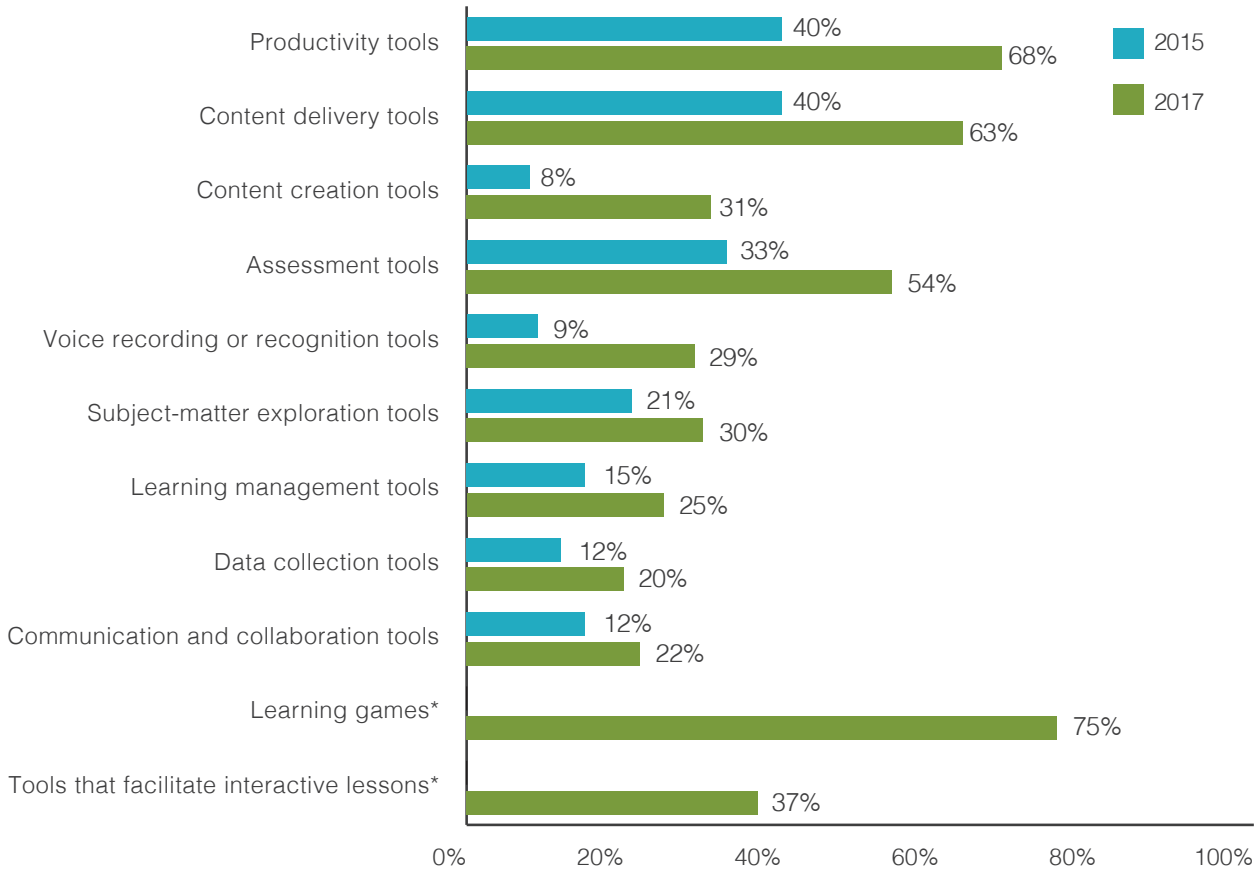
Source: Teacher survey 2015, 2017. n=1019-41.

teachers and students, technology was most often used for activities related to research (i.e., finding information) and content creation.

The technology tools that students used most frequently aligned with these reported activities. Across all grades, the most commonly used technology tool was learning games (often used for practicing core skills), with 75% of teachers reporting their students used such games at least weekly. The student survey responses revealed that younger students played more learning games than older students, with 61% of surveyed elementary school students reporting they played at least a few times a week compared to just 30% of middle and high school students. Other frequently used tools included productivity tools, content delivery tools, and assessment tools. For each of these categories, 54-68% of teachers reported their students used these types of tool at least weekly (Figure 9).

Student experiences of the technology are also important, as learning is most productive when students are happy and engaged. The student surveys reveal that learning games were by far

Figure 9. Technology tools used at least weekly by students in 2015 and 2017



*Source: Teacher survey 2015, 2017. *2015 data not available.*

the favorite iPad activity for elementary school students, with over 1 in 3 students mentioning them as the "most exciting or interesting thing" they had done with their iPad in school. Among middle and high school students, presentations and iMovie were the most frequently mentioned as being "interesting or exciting," followed by learning apps. In general, these results suggest that students are finding classroom uses of technology engaging, an important first step toward learning.

Increases in classroom technology use were sometimes accompanied by increases in innovative uses of technology

Beyond increasing technology access and use in high-poverty classrooms, the initiative also aimed to close income-related gaps in technology use in the classroom by encouraging more innovative and student-centered activities. This research distinguishes between innovative uses of technology (in which students are ***using technology*** in new ways and for new purposes) and innovative learning opportunities (in which students are ***learning*** in new ways). Sometimes the two go hand-in-hand, for example when new uses of technology facilitate new types of learning; and sometimes the two are decoupled. While the research considers these factors separately, teachers do not always make these same distinctions. From the teachers' perspective, when talking about technology-based activities they did with their students, teachers overwhelmingly expressed the belief that their students were more engaged and learned more with their iPads than they did from engaging in traditional non-technology learning activities.

Based on teacher reports, the surveys suggest that in classrooms where students used technology more, students were also more likely to use technology in innovative ways. Among teachers whose students used technology for three-quarters of class time or more, 18% used technology to do tasks or learning activities "that would not be feasible without the technology" at least once in spring 2017, compared with just 9% of teachers whose students used technology for one-quarter of class time or less.

Teachers also provided descriptions of student activities they considered innovative. In some cases, these activities were new in that they involved technology, but the ***underlying learning activity inherent in the task was not particularly new.*** For example, many teachers described their students creating digital recordings of their work (e.g., audio recordings and videos). In essence, these activities often constituted technology-enhanced versions of traditional presentations or projects (in which students synthesized their understanding and presented it to their peers and/or parents).

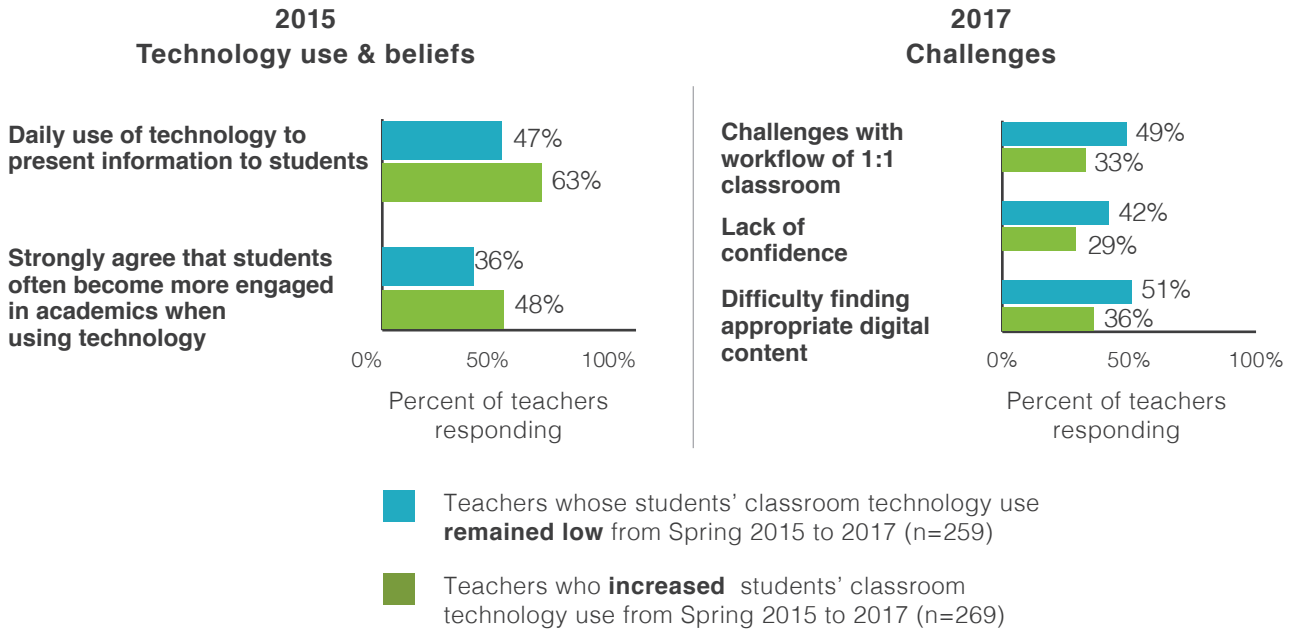
In other cases, teachers described activities that were innovative not just because of inclusion of a technology component but also ***because the learning task was substantially different than it would be otherwise.*** For example, some students used the slow-motion features of videos to analyze phenomena in science, engineering, or dance that happen too quickly to see clearly with the naked eye. Other students conducted virtual hip resurfacing surgery to learn about the skeletal system and anatomy. Students also went on virtual

field trips, or contributed to crowd-sourced research through Zooniverse. In tasks such as these, the technology helped students access technology-dependent opportunities for critical thinking and other aspects of deeper learning.

Teachers who increase classroom technology use share certain characteristics that may support uptake

Looking at patterns of technology use, we find about 69% of participating teachers started out with relatively low classroom use of technology; of those, some (38%) increased their classroom use of technology drastically, while others (another 38%) use remained virtually unchanged.[3] What factors are associated with these differences in uptake? Background factors, like years of teaching experience and grade level or subject area taught, did not influence patterns of uptake. Teachers who increased the use of technology in their classrooms tended to use technology more themselves before the initiative began and had slightly more positive attitudes toward educational technology at the outset. The figure below (Figure 10) illustrates these differences between teachers who started out with low student use of technology and stayed there, as compared with teachers who started out with low student use of technology

Figure 10. Differences between teachers whose students' classroom technology use remained low vs. increased during the Apple and ConnectED initiative



Source: Teacher survey 2015, 2017.

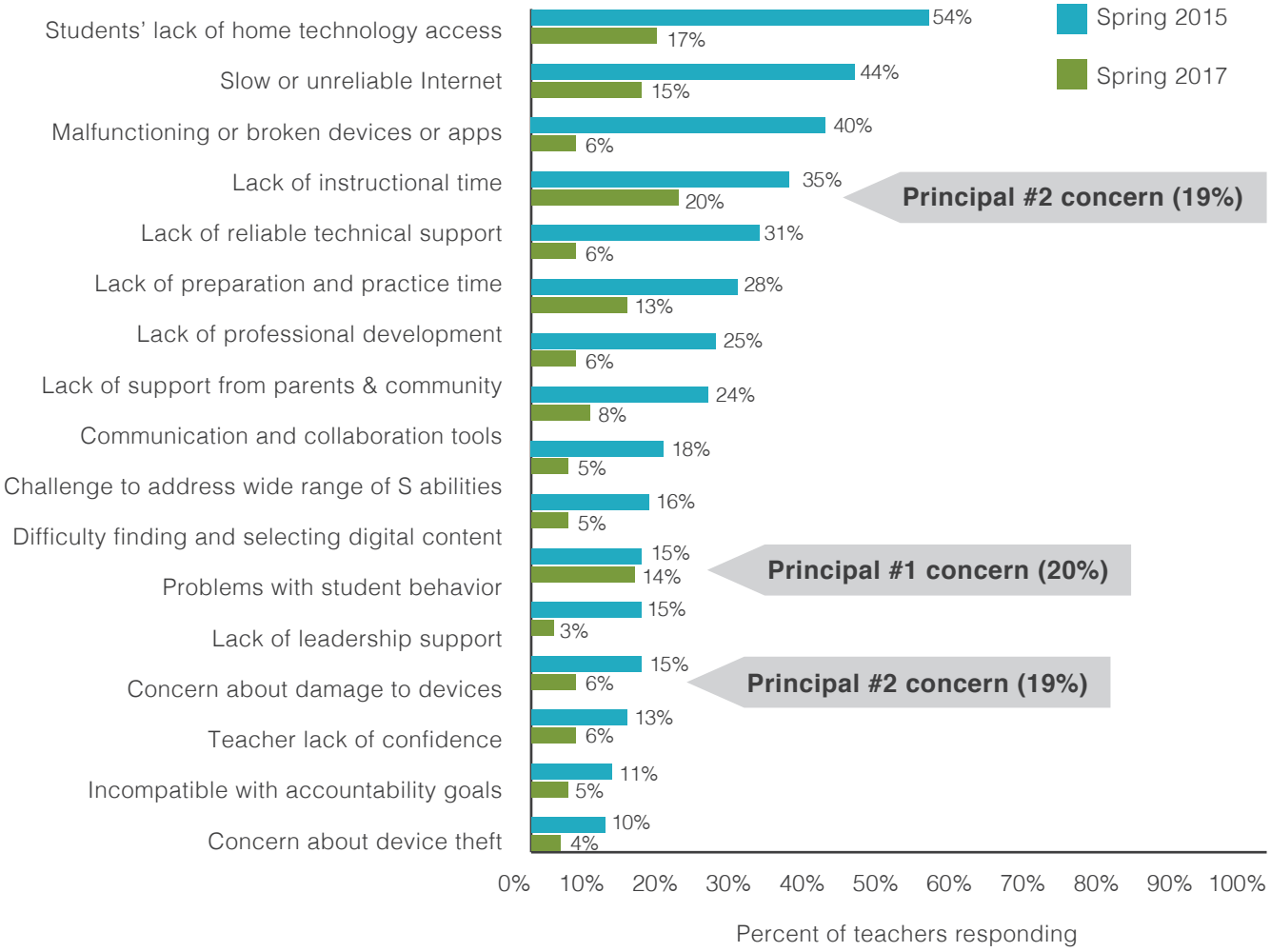
3 Teachers with "low student use of technology" are those who reported that students spent one-fourth of class time or less using technology. Teachers who "remained low" stayed at this same level; teachers who "increased their classroom use of technology drastically" are those who jumped from one-fourth of class time or less to three-fourths of class time or more.

but moved to greater use. These profiles highlight findings from previous research that teachers' varying levels of comfort with educational technology often do influence their uptake, and that varying levels of support are required to meet teachers where they are and support them in productive technology integration (Ertmer & Ottenbreit-Leftwich, 2013; Harper & Milman, 2016).

Perceived challenges to using technology in instruction decreased greatly from baseline

Prior to the initiative, teachers in these high-poverty schools faced a number of barriers associated with implementing technology in the classroom. Each of these barriers diminished drastically as the initiative got underway (Figure 11). In spring 2015, teachers' concerns about using technology at their schools centered primarily around

Figure 11. Obstacles to using technology in the classroom perceived as "major"



Source: Teacher survey 2015 & 2017, School leader survey 2017. n=996-1099 teachers, 83 principals.

issues of access and reliability, with the top five concerns being students' lack of home technology access; slow or unreliable internet; malfunctioning or broken devices or apps; lack of instructional time; and lack of reliable technical support. While 31% or more of teachers cited these concerns as major challenges in 2015, that number decreased to 20% or less in 2017. These findings demonstrate the initiative largely met its goals around reducing impediments so that teachers could count on reliable access to working computers and the internet, supporting the possibility of efficient and effective use of technology in the classroom.

Concerns about not having enough instructional time to allow for technology integration also decreased notably (from 35% to 20% of teachers citing this as a major concern). This change suggests that if access is smooth, technology use takes less time away from instruction than it might otherwise. This finding is important, given that the risk of detracting from focused instructional time is a common concern about technology integration, particularly in schools where the pressures of accountability mandates are strongly felt (Warschauer & Matuchniak, 2010). The initiative appears to have alleviated other concerns teachers had at baseline, too; for example, the need for professional development and support for finding relevant resources and ways to align the use of technology with existing accountability requirements. There was one exception to the idea that concerns about challenges decreased over time; the portion of teachers reporting "problems with student behavior" remained constant at about 15% from baseline to follow-up.

We also asked principals about this same set of challenges, and student behavior was the top concern (with 20% citing it as a major challenge in 2017). These findings may indicate school-wide technology policies and classroom management need attention in order for technology integration to be productive. For example, some participating schools implemented tools that allowed teachers to take over control of students' devices at certain times to minimize distractions. Teachers need to adjust their classroom management strategies to fit a new environment in which students use devices. Schools looking to implement technology integration initiatives should not overlook these factors.

Students had predominantly positive things to say about using iPads for school. The survey for middle and high school students also asked directly about concerns related to using iPads at school.[4] Among the 46% of middle/high school students who reported anything negative about using iPads, two concerns emerged. First, students were concerned about increased distraction from learning. According to these students, the distraction was typically due to the misuse of the devices by other students rather than their own activities. However, students also complained about restrictions that prevented their use of many websites and applications.

4 The student survey for elementary school students was kept short, given the age of the respondents, and thus did not include this question.

Discussion of Changes in Technology Use

The survey data show that teachers and students increased their use of technology during the Apple and ConnectED initiative. This finding is not surprising, given that a key feature of the initiative was the introduction of 1:1 computing into schools—but affirms that some foundations for success have been established. Further, the patterns of technology use are instructive: teachers whose students used technology more frequently also reported students were using technology in what they perceived as innovative ways, and to engage in learning activities that might not have been as convenient, or perhaps even possible, without the technology. The findings also suggest some teachers may be better positioned to integrate technology into teaching and learning than others—namely, teachers who have more experience and more personal confidence with technology, and those who believe more strongly in the power of technology to support learning. Understanding the importance of these tendencies and dispositions is informative not only for this initiative but also to support teachers with integrating technology into instruction. Finally, the survey findings are encouraging as they demonstrate that once the initiative got underway, teachers had fewer concerns about integrating technology into instruction. The initiative appears to have successfully resolved the problem of adequate and reliable technology access for students, such that teachers no longer cited these issues as major impediments to using technology in their instruction.

Deeper Learning Opportunities for Students

The Apple and ConnectED initiative's theory of change suggests that as teachers use technology more, their instruction will include more opportunities for students to develop the skills and dispositions needed to learn academic content more deeply and to thrive in the 21st century. This "deeper learning" is a key goal of the initiative, and a commensurately important focus of this research.

The 2017 survey examined five dimensions of deeper learning that might be supported through technology (four of the five dimensions were also included on the 2015 baseline survey). These constructs are based on a long history of learning sciences research (see, for example, National Research Council, 2000). The survey measured a finite set of hallmarks of each dimension, as summarized below.

Teamwork can give students the opportunity to help each other learn the content of their work more deeply. It includes:

- group work, in which students interact in pairs or small groups on their learning activities, and
- giving students collective responsibility for a shared product they must develop together.

Communication and creation is an integral part of the shift from passive exercises to active learning experiences. These activities can deepen learning when students are asked to:

- create products that express what they know or think,
- attend to an audience, considering others' levels of understanding when crafting a communication, and
- attend to principles of design in fields appropriate to their creation, such as video production or newspaper editing.

Personalized learning can inspire students to go deeper in their learning and develop a sense of ownership by making learning experiences meaningful and appropriately challenging for each student. It can be accomplished by

- varying learning tasks to match learning needs, and
- offering students the opportunity for significant choices in pursuing their interests.

Critical thinking engages students in analysis, interpretation, synthesis, evaluation, or solution generation for a significant proportion of the lesson.

Real world engagement[5] helps students connect academic learning with issues and applications in real-life settings. It includes:

- immersion of students' work in the world using physical or virtual real-world environments, and
- asking students to take on a realistic task that professionals or adults might do.

Both conceptually and in practice, considerable overlap exists among these dimensions. Indeed, the 2017 survey results confirmed the deeper learning constructs are interrelated, showing that teachers who provided more opportunities along one dimension of deeper learning also tended to provide more opportunities along the others.[6]

The teacher surveys measured each dimension of deeper learning using a scale that included the key hallmarks described above. Teachers were asked to report on the frequency with which they provided activities that involved deeper learning in the spring semester of 2015 (baseline) and the spring semester of 2017 (follow-up). The analyses primarily examined change over time, and compared average scale scores and average scores on sub-items of each scale across the two years.[7] As such, they included only teachers who responded to both the 2015 and 2017 surveys.[8]

5 The 2015 baseline survey did not include questions about real-world engagement, so this construct is not included in the analyses of change over time for deeper learning.

6 The effect size of these statistically significant correlations among the deeper learning topics ranged from 0.32 (medium) to 0.61 (strong).

7 Each of the deeper learning scales combines more basic with more advanced levels of the construct. Changes in scale scores provide a sense of overall gains on each construct. However, they do not tell us the extent to which the changes took place at the more basic or more advanced levels.

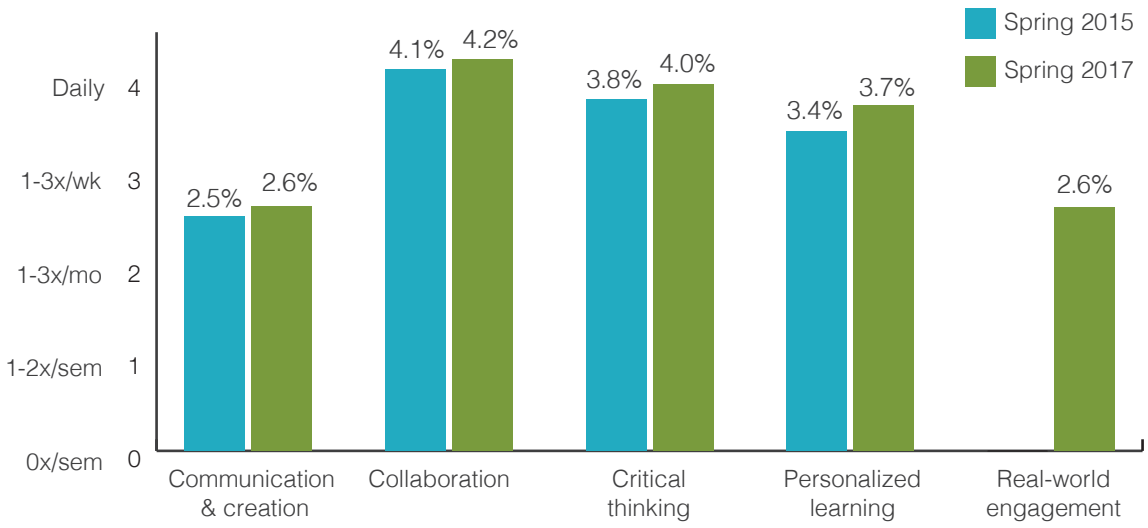
8 Sample sizes for questions related to deeper learning ranged from 1,168 to 1,301.

The overall frequency of deeper learning opportunities increased slightly over time

The theory of change for the Apple and ConnectED initiative posits that deeper learning opportunities will increase later in the initiative, after technology becomes more integrated into instruction and teachers begin changing their practices more substantially (see Appendix).[9] And yet, an important and promising finding from the surveys was that all four measured dimensions of deeper learning showed increases from the 2015 baseline to 2017 (Figure 12). These changes are relatively small in magnitude, at least in part because the baseline frequencies were higher than expected, but they are statistically significant.[10, 11] At the same time, the theory bears out when we look more intensely at the types of deeper learning that are being implemented: in many cases teachers are starting out with more basic forms of deeper learning, while more advanced forms of deeper learning are not yet commonplace.

As the figure illustrates, the largest gains were in personalized learning opportunities. Specifically, during the 2016-17 school year, students were more frequently allowed to choose the topics they would explore

Figure 12. Frequency of opportunities for deeper learning in spring 2015 and spring 2017



*Source: Teacher survey 2015 & 2017. *p < .01, ***p <.001. From left to right, number of respondents were 1168, 1271, 1241, and 1220, while Cohen's d were .09, .15, .19 and .31.*

9 This framework is consistent with findings from decades of technology integration efforts (Fisher, Dwyer, & Yocam, 1996; Warschauer & Matuchniak, 2010; Ertmer & Ottenbright-Leftwich, 2013).

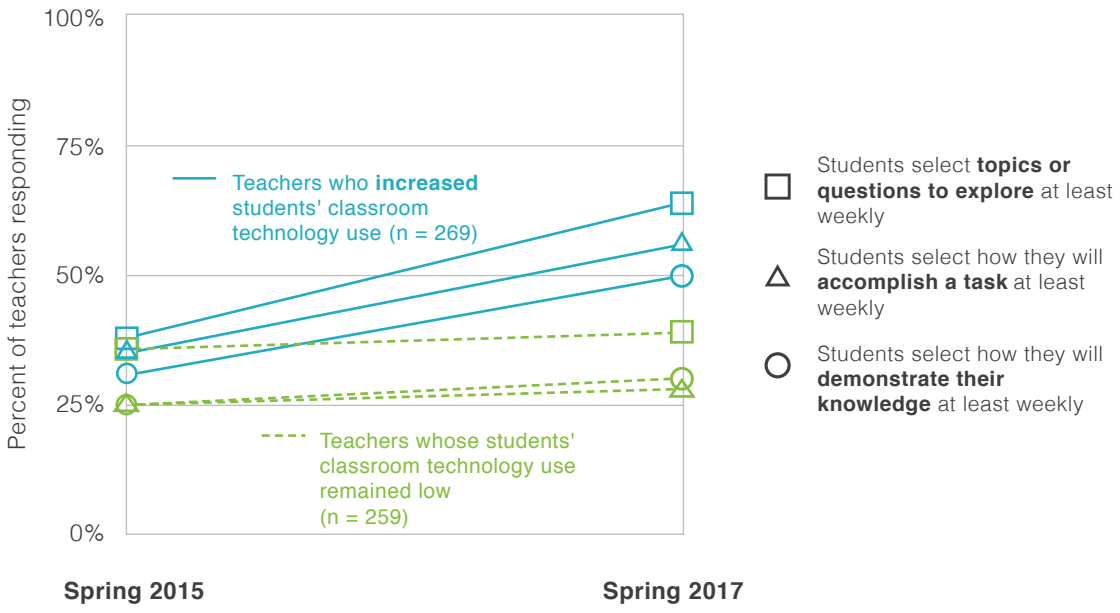
10 The increases ranged from .09 standard deviation units (communication and creation) to .31 units (personalized learning).

11 Teacher self-reports of their practices are often more optimistic than observers' judgments (Mayer, 1999; Camburn & Han, 2006). The baseline responses about deeper learning opportunities could reflect this bias toward a desirable response.

for a project or assignment and to decide how to accomplish an assignment or task. The ongoing case study research has also revealed similar patterns, with widespread reports of projects or products involving student choice, and of students having newfound opportunities to look up information themselves in real time based on their own interests or learning needs.

Importantly, we see a relationship between technology use and personalized learning opportunities: increases in personalized learning were specifically reported by teachers who increased the use of technology in their classrooms (Figure 13). Teachers who reported increasing students' classroom technology use from baseline to 2017 (n=269) also reported that their students had more opportunities for personalized learning during that time. In contrast, personalized learning opportunities remained approximately the same for students of teachers who used technology during less than 25 percent of class time in 2017 (n=259). Together, these findings suggest that across the initiative, some teachers capitalized on the fact that each student had a device, and that some of the more commonly used apps lent themselves to greater personalization by allowing students to work at their own pace (e.g., adaptive reading and math programs or games) or to choose how to express their knowledge (e.g., Keynote and iMovie).

Figure 13. Changes in personalized learning opportunities associated with technology use in the classroom



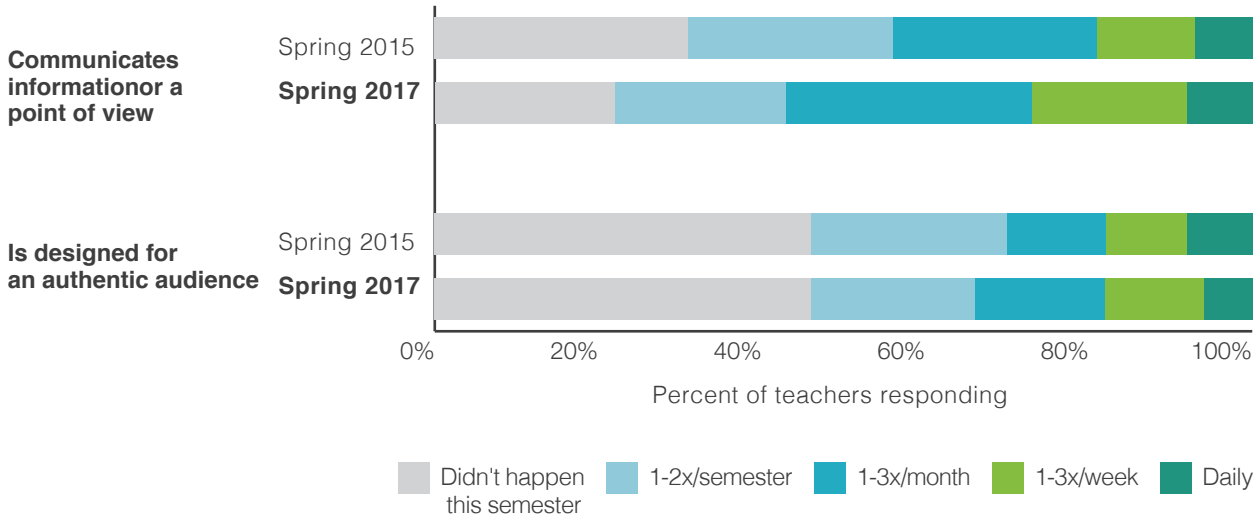
Source: Teacher survey 2015 & 2017.

Opportunities for students to develop communication and creation competencies were the least common of the deeper learning dimensions at baseline, and the overall gains in 2017 were small. Analysis of the sub-items of this construct revealed that in 2016-17 students were creating products to communicate their ideas more frequently than they were before (Figure 14), which is consistent with the unique affordances of iPads for creating a variety of products, for example, through the variety of applications that all students had on their devices for creative expression, such as Keynote, iMovie, and GarageBand. However, responses to the sub-items also reveal that while students were creating more products, the complexity and substantive quality of those products had not increased at the same rate. This lag between frequency and quality might reflect the fact that many schools are in the relatively early stages of implementation. As technology integration deepens over time, teachers and students may turn to more complex activities that focus on more advanced aspects of communication and creation, such as attending to the needs of their audience or applying principles of design.

Elementary school teachers were responsible for most of the increase in deeper learning opportunities

Important differences emerge between elementary teachers and middle and high school teachers with respect to shifting practices to incorporate deeper learning opportunities for students. Elementary teachers increased the frequency of deeper learning opportunities in their classrooms in all four dimensions between 2015 and 2017. High school teachers, in contrast,

Figure 14. Changes in opportunities for communication and creation over time



Source: Teacher survey 2015 & 2017. n=1194-1281.

stayed at the same levels across all deeper learning dimensions, and middle school teachers increased opportunities for personalized learning but showed no increase in collaboration, critical thinking, or communication and creation.

This variation may be partly explained by the nature of learning opportunities that can support test proficiency at each level. For example, results from the student survey suggest that adaptive learning games likely drove much of the increase in personalized learning across levels. According to teacher survey data, these personalized learning games were used much more widely in elementary schools than in middle and high schools. At the elementary school level, these learning games focused on reading and mathematics and were regarded as supporting basic skills development and therefore enhanced test performance. In contrast, at the high school level, teachers reported struggling to introduce digital learning activities without feeling they were detracting from lessons that would more directly support test performance.

Discussion of Deeper Learning Opportunities for Students

The survey data show small but statistically significant increases in teacher-reported deeper learning opportunities across all dimensions of deeper learning, but these gains are generally limited to the elementary school level. These gains are notable because they demonstrate that students are indeed beginning to encounter opportunities to develop important 21st-century skills and deep conceptual understanding of content.

Teacher Descriptions of Increased Deeper Learning Opportunities

"More critical thinking, more hands on…independent learning project with student choice."

- Elementary school teacher

"We are now able to do more in depth research. We also "create" more now. We create movies, stop motion, presentations, etc."

- Middle school teacher

"[We use] interactive applications on student iPads to foster collaboration and facilitate the connection making process between historical concepts and implications for their own lives."

- Middle school teacher

Further, the timing of the reported gains is also consistent with the expected progress of change over time: the particular components of deeper learning that have increased the most so far represent the "low-hanging fruit," while the components that have increased less or not at all tend to reflect more complex instantiations of deeper learning. With time, teachers may expand their use of deeper learning strategies to incorporate more elements of deeper learning. At this point in time, there is still room for growth in terms of how often teachers provide opportunities for some of the more advanced aspects of deeper learning, such as designing for authentic audiences or having more intellectual responsibility for problem-solving and analysis.

Apple Resources and Support for Change

The Apple and ConnectED initiative included a comprehensive set of services intended to provide schools the support they needed to get started with technology-supported, student-centered instruction. In addition to infrastructure upgrades and technology management, the initiative included ongoing professional learning for school leaders and teachers as they integrated technology into their schools and classrooms. This support included much more time spent with school leaders and teachers than is typical for most educational initiatives (Drayton et al., 2010; Shapley et al., 2010). Specifically, each of the 114 participating schools was assigned: a) a member of Apple's team of DEs, who worked closely with school leadership on strategic planning and instructional leadership, and b) a dedicated Apple APL Specialist, who devoted a total of 17 days onsite working with teachers in the school's first year of implementation and integration.[12] The APL Specialist provided onsite professional learning that was individualized for each school—i.e., designed to be responsive to the needs, interests, and capacity of the individual school. The APL Specialists engaged teachers in activities such as: 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. Overall, both principals and teachers appreciated and valued these professional learning offerings.

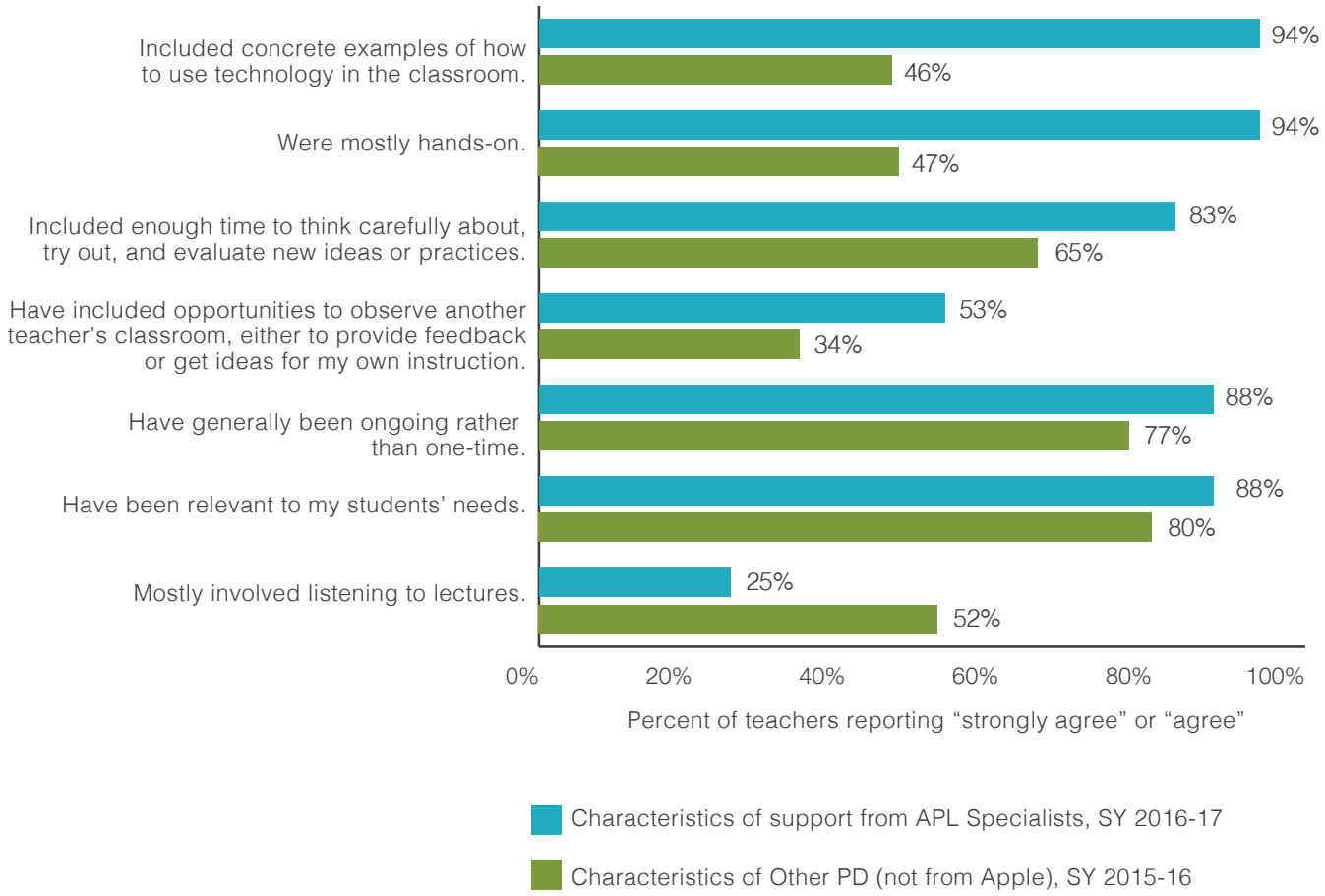
Teachers reported that support from their APL Specialist was notably different from their other professional development experiences

Teachers saw the support they received from APL Specialists as distinct in nature from other PD they had received. In 2015, teachers were asked to describe the characteristics of their typical professional development sessions prior to the initiative. Using the same features, the 2017 survey then asked teachers to characterize the PD they had received from APL Specialists as part of the initiative. The characteristics the surveys asked about were taken from the literature on teacher professional development (e.g., Desimone, 2009; Garet et al., 2001; Penuel et al., 2007). This literature points to many features of PD that matter for teacher learning, such as whether the PD was a one-time event or provided ongoing support for teachers; whether the PD was lecture format or provided hands-on opportunities for teachers to practice new skills; and whether the PD was generic or tailored to the specific needs and circumstances of the participating teachers, etc.

In contrast to PD they had received prior to the initiative, teachers characterized the professional learning they received from APL Specialists as involving more hands-on activities and less lecturing (Figure 15). Teachers also commented that the support from the APL Specialists was more

12 Following the first year of implementation, Apple is continuing to support schools toward sustainability, although the data collection reflected in this report primarily represents the initial stage of supports for each school.

Figure 15. Characteristics of the support from APL Specialists as compared with other PD



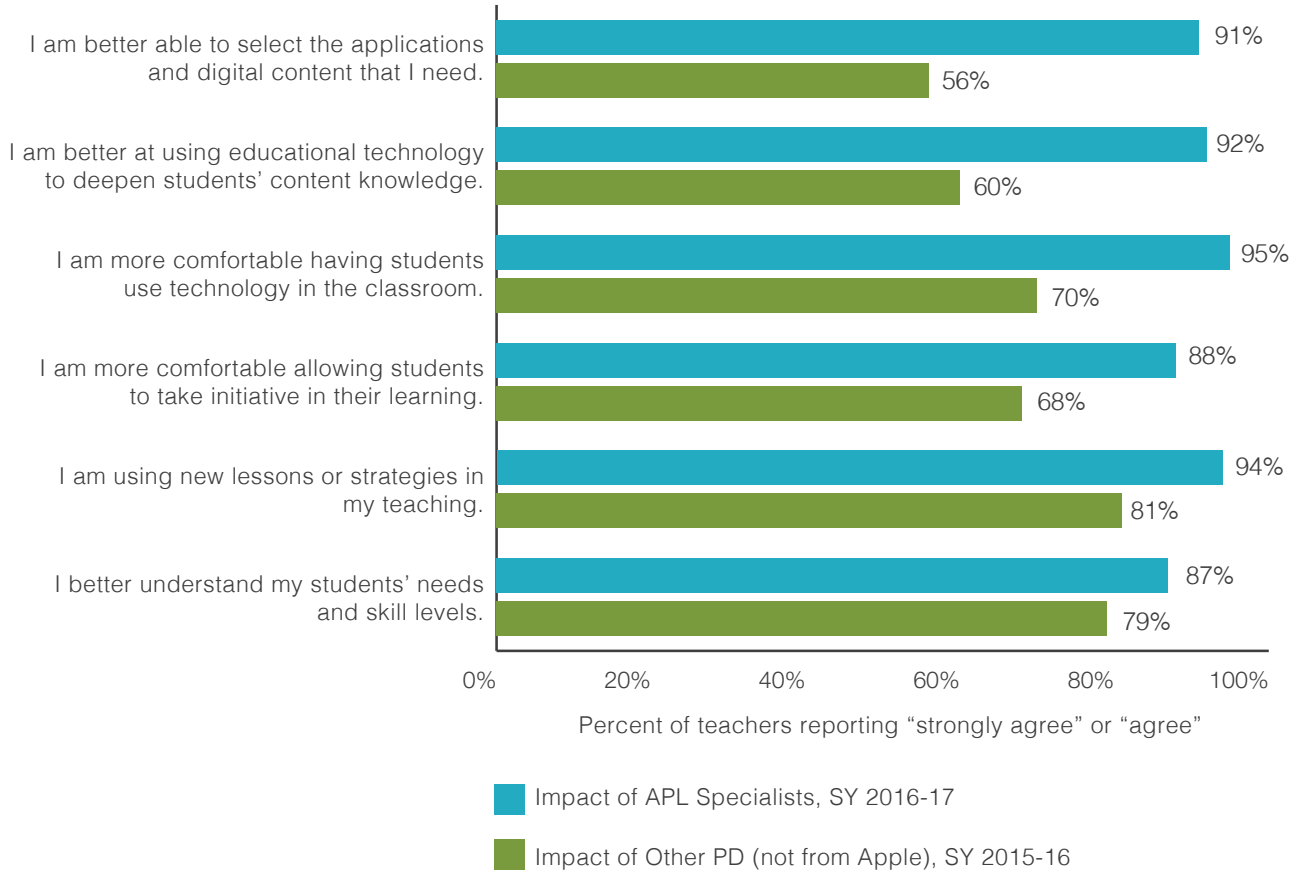
Source: Teacher survey 2015 & 2017. n=790-832. Sample includes only those who had not yet began the Apple and ConnectED initiative at the time of the 2015 teacher survey.

personalized, more one-on-one, more directly addressed their needs, and included more follow-up than PD they had received from other sources. One teacher wrote, "It was much more tailored to the needs of my classroom, content and students." Another said, "It was more interactive and led us to create things that we could actually use in the classroom." Only a small portion of teachers were neutral about the support they received and still fewer found the support did not meet their specific needs (e.g., indicating the support did not include any information about Special Education students, or that it focused too much on some subject areas and not enough on others).

Teachers found the support from their APL Specialist to be highly valuable and reported it had a strong, positive impact on their work

Perhaps because of these differences in the character of the professional supports, teachers were more likely to rate Apple's professional learning as having strong benefits for their practice than other PD they had received (Figure 16). The categories with the largest differences (all related to comfort and skills with using technology for teaching) are not surprising, given that the prior PD they were describing may or may not have addressed technology at all. However, differences also emerged for impacts not related to technology. Compared with traditional PD, more teachers reported that the APL Specialists had a strong impact on their comfort in letting students take initiative for their learning; using new lessons or strategies in teaching; and understanding students' needs and skill levels. These results speak to the value of Apple's professional learning for

Figure 16. Perceived impact of the support from APL Specialists as compared with other PD



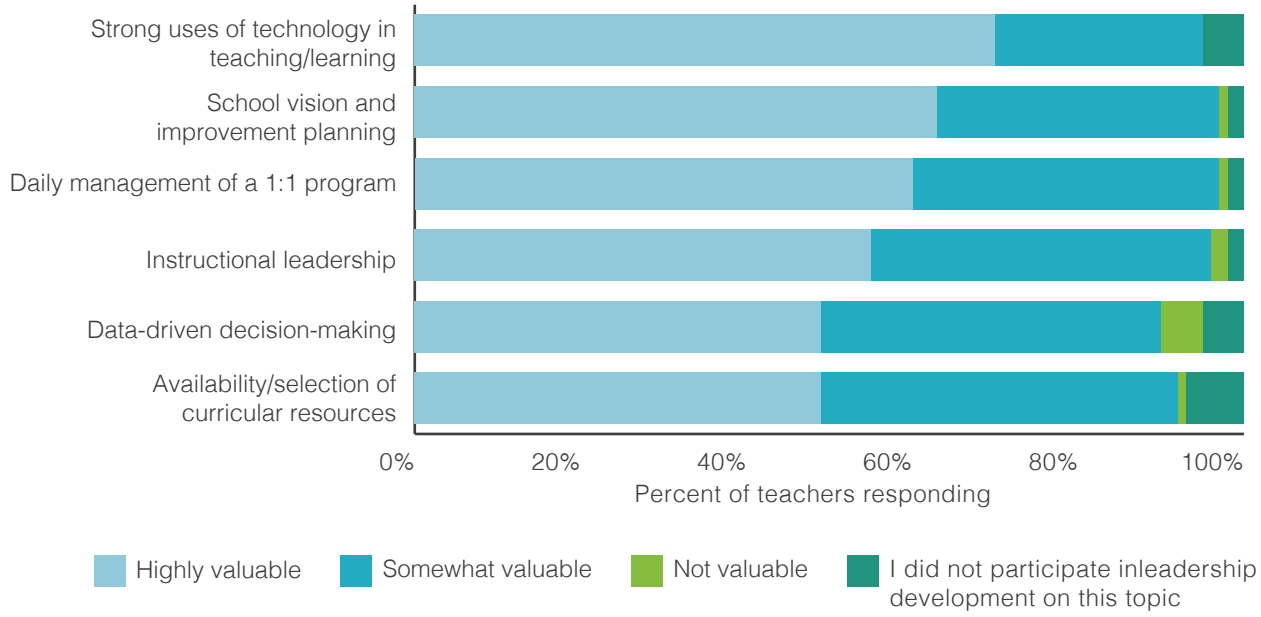
Source: Teacher survey 2015 & 2017. n=762-798. Sample includes only those who had not yet begun the Apple and ConnectED initiative at the time of the 2015 teacher survey.

helping teachers to personalize or differentiate learning and to give students some autonomy for their own learning. Finally, comparing teachers who reported the strongest outcomes from the support from their APL Specialists and those who reported less benefit, the former reported strong outcomes also changed their practices more by increasing student technology use and deeper learning opportunities, and they reported stronger student outcomes. These relationships suggest connections between support from the APL Specialists, changes in teaching practice, and ultimately student outcomes are plausible.

Principals valued the leadership support they received

For principals, Apple's ConnectED leadership development covered topics such as overall school vision and instructional leadership, daily management of a 1:1 program, and strong uses of technology in teaching/learning. Principals responded positively to this support. Of the 82 principals responding to the survey, 90-96% said their work with the DE was valuable across the topic areas, and 49-70% of principals described it as highly valuable. (Figure 17).

Figure 17. Extent to which school leaders found Apple's leadership development activities to be valuable on various topics



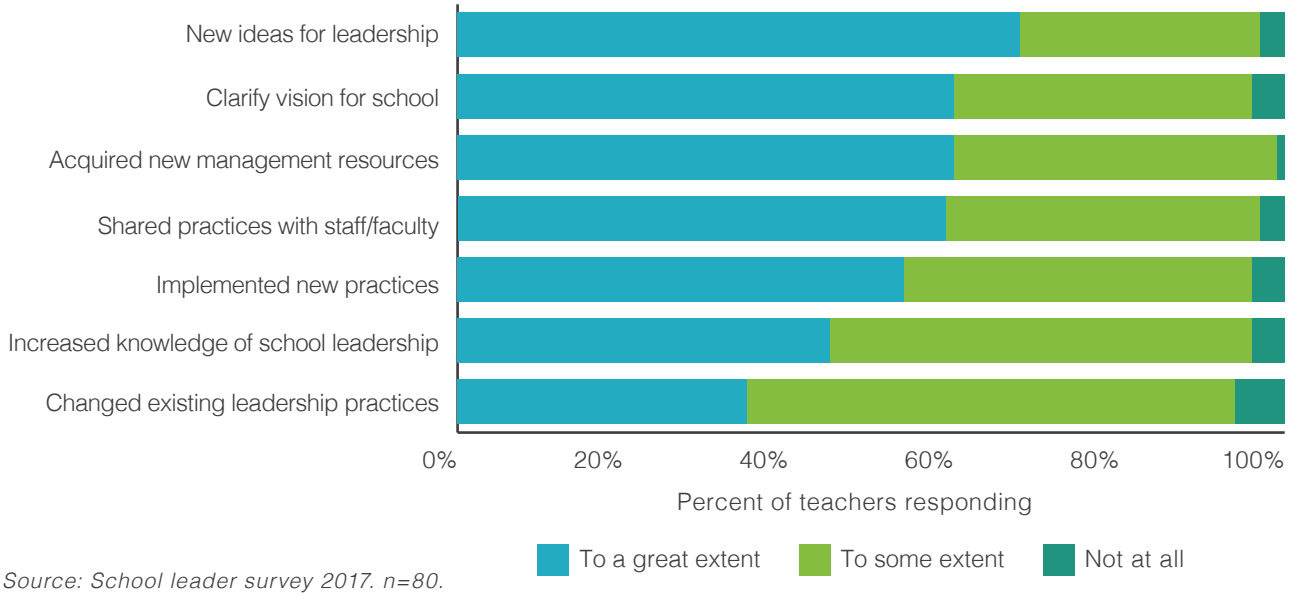
Source: School leader survey 2017. n=82.

Principals also reported that the professional learning they received impacted specific leadership capacities (Figure 18). More than 90% reported the interactions were valuable for building knowledge of school leadership, clarifying a vision for their school, gaining new ideas for leadership, changing existing leadership practices and using new practices, gaining management resources, and sharing practices with their staff or faculty. Perhaps not surprisingly, existing practices proved most difficult to change, with only 35% of principals stating the professional learning had changed existing leadership practices to a great extent.

Discussion of Apple's professional learning offerings

The survey findings show that on average, principals and teachers greatly valued the professional learning experiences associated with the Apple and ConnectED initiative. Apple was intentional in the design of the professional learning they provided, following research-based practices that emphasize the importance of tailored, hands-on, and ongoing support for teachers. Teacher reports show that Apple was generally successful with this design: most teachers reported the support they received from their APL Specialists was notably different from other PD they had received, in precisely these ways. Moreover, teachers reported that working with their APL Specialist was more impactful than other PD they had received. Teachers who found the APL Specialists most impactful, also reported greater technology use in the classroom, more deeper learning opportunities for students, and stronger student outcomes, as compared with teachers who found the professional learning less impactful. Further investigation is needed to understand why some teachers find this type of professional learning more valuable than others do. Are there differences in the offerings that different teachers experienced, or are some teachers simply better positioned to take advantage of the available support?

Figure 18. Extent to which Apple leadership support benefited school leaders' work



Source: School leader survey 2017. n=80.

Principal and Teacher Attitudes and Beliefs

Because attitudes and beliefs often drive behavior, examining teachers' views about teaching and technology can help us understand and contextualize findings about changes in their practice (Ertmer & Ottenbreit-Leftwich, 2013). In 2015 and 2017, the principal and teacher surveys included a series of questions to gauge attitudes and beliefs about topics relevant to the Apple and ConnectED initiative's theory of change, such as philosophies of teaching and learning, beliefs about the role and value of educational technology, perceptions of the school environment and leadership, sense of professional agency or influence, and job satisfaction. The analysis of these questions focused primarily on change over time, with some comparisons of principal and teacher beliefs. The sample included responses from principals and teachers who took the survey in 2015 and again in 2017. In comparisons of beliefs, it is important to remember that the baseline survey was given after schools knew they had been selected to participate in the initiative, so baseline measures could already reflect some degree of excitement about the promise of technology.

Principals and teachers have maintained their positive outlook on many aspects of their school climate

A variety of factors comprise what people understand to be the "climate" of a school. These factors are important because they reflect how principals, teachers, and students feel about the direction in which the school is moving and their own place within that milieu.

When the Apple and ConnectED initiative began in 2015, principals and teachers at participating schools expressed strongly positive views about their school climate, and these views have remained strong as implementation has progressed. For example, at baseline, more than 80% of teachers agreed or strongly agreed that:

- teachers at their school are regularly involved in discussions of school improvement;
- they are encouraged to stretch, grow, and experiment with new ideas to improve teaching; and
- principals, teachers, and staff are willing to take risks to make their school better.

In spring 2017, teachers' views on most aspects of school climate remained similar to baseline. Teachers did report slightly more positive views about the consistency of programs and curricula at their schools than they had at the beginning of the initiative; the change was small but statistically significant. It is possible that the initiative's breadth and scope within each school contributed to this view of improved coherence. That is, this is a whole-school initiative that attempts to

promote elements of a coherent vision and to coordinate practices across teachers. Qualitative data from ongoing school case studies are consistent with this hypothesis; they illustrate how the initiative has become a significant focus of attention and effort in those schools.

Principals were even more positive at baseline than teachers. For example, in the 2015 survey more than 90% of principals agreed or strongly agreed that:

- research and best practices are discussed frequently at the school;
- their school climate encourages experimentation with new ideas to improve teaching and learning; and
- there is strong collegiality among faculty and staff, and regular collaboration within and among grade levels and departments.

Given that principals started out with such positive views, and thus had little room for "growth" in these areas, it is not surprising these attitudes did not get more positive as implementation progressed. However, the continued positive results from both teachers and principals suggest the initiative has been a good fit and well-integrated into the context of most schools.

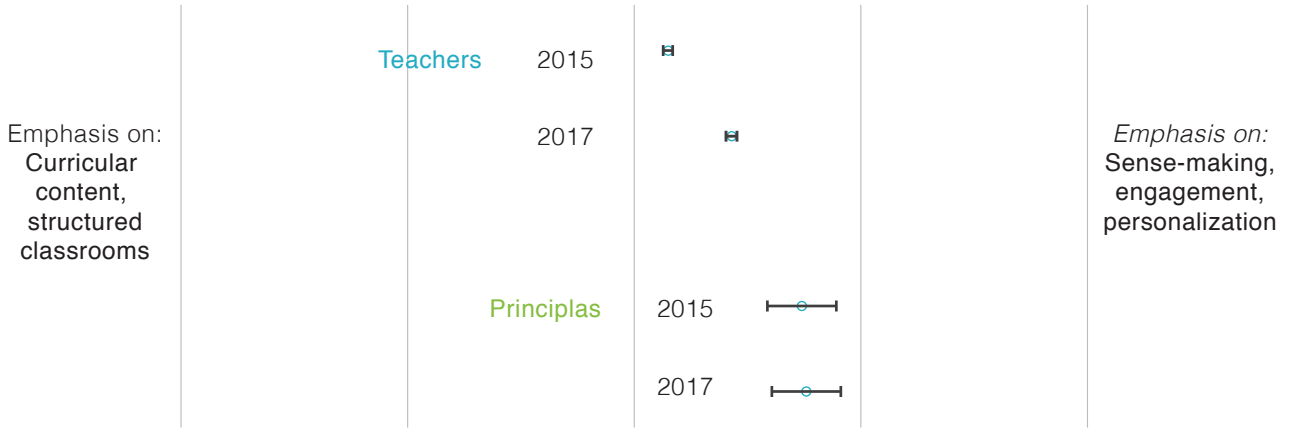
Teachers' pedagogical beliefs shifted slightly toward student-centered pedagogy, while principals' beliefs remained unchanged

The evolution of teaching practices toward more student-centered approaches and learning environments is a desired outcome of the Apple and ConnectED initiative. Such changes cannot occur unless teachers' attitudes and beliefs evolve toward a more student-centered stance (Ertmer & Ottenbright-Leftwich, 2013). To measure attitudes and beliefs about instruction, the surveys asked principals and teachers to place themselves on a 5-point continuum for a series of choices between different pedagogical perspectives. The choices at one end of the continuum emphasized the importance of curricular content and having structured classrooms. At the other end of the continuum, the choices emphasized personalization and students' sense-making and engagement. The survey items were written to avoid making one end of the continuum sound better than the other.

Figure 19 places the average scores for teachers and principals at baseline and in 2017 on this continuum. The data show a shift in teachers' beliefs over time in the direction of an emphasis on sense-making, engagement, and personalization, moving from an average score of 2.15 in 2015 to 2.43 in 2017 (n=1,556). This change is statistically significant and represents a medium-sized effect.[13] This finding suggests

13 The effect size was 0.43 standard deviation units.

Figure 19. Change over time in principals' and teachers' pedagogical beliefs



Source: Teacher survey 2015 & 2017; School leader survey 2015 & 2017. $n_{teacher}$= 556, n_{leader}=76. Blue dots represent means, while error bars represent 95% confidence intervals.

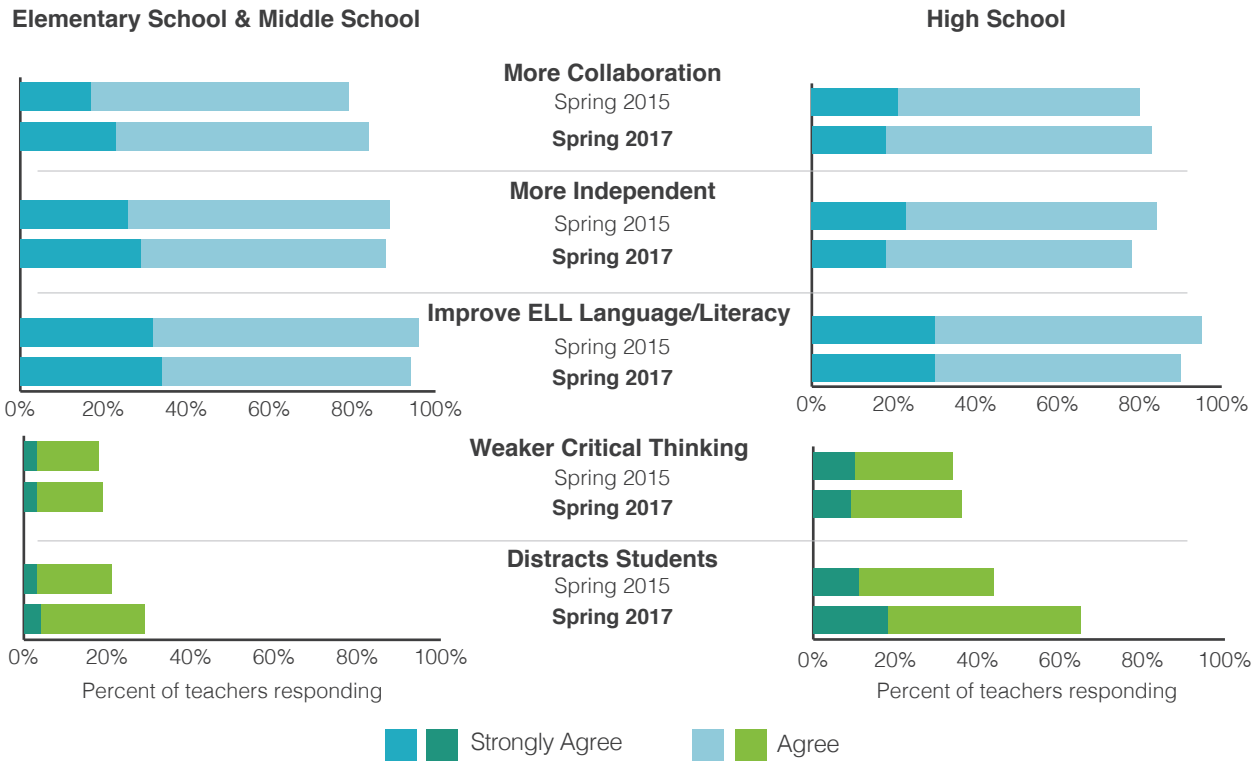
that the initiative is beginning to have the desired effects. Principals' pedagogical beliefs started out with a stronger student-centered orientation than those of teachers, and did not change over this timeframe.

Teachers' views of educational technology remained strongly positive overall, though some reservations about educational technology emerged, especially among high school teachers

Teachers were asked about how they believe technology might influence classroom teaching and learning, including both positive effects (e.g., improvements for English learners or greater independence in the learning process) and negative effects (e.g., greater distraction or weakened critical thinking). Figure 20 shows that teachers' baseline views of technology were highly positive. Across most categories, attitudes toward technology in spring 2017 remained high overall, but dipped slightly from baseline levels. These dips are slight yet fairly consistent across most categories measured. Importantly, these dips were more pronounced for high school teachers than for elementary or middle school teachers.

One possible explanation for these grade-level differences, supported by the case study data, is that the initiative interacts differently with school improvement and accountability mandates in high school than in the earlier grades. In one case study, a high school facing strong accountability pressures, for example, teachers viewed the initiative as detracting from the goal of improving test scores. By contrast, at one elementary school in a similar situation, increased access to engaging learning games was seen as supportive of the mandate to elevate test scores. As noted

Figure 20. Changes in views of educational technology, by school level



Source: Teacher survey 2015 & 2017. $n_{ES/MS}$*=1339-1378,* n_{HS}*=128-133.*

previously, the student survey revealed that games were used extensively at the elementary level to support basic learning (and, theoretically, test score improvement) in math and reading, but were uncommon in high schools.

Discussion of Principal and Teacher Attitudes and Beliefs

Baseline views of school climate, pedagogical beliefs, and attitudes about the role and potential of educational technology to enhance student learning were remarkably high, making it difficult to discern positive effects of the Apple and ConnectED initiative on these parameters.

The small shifts in teachers' stances toward more student-centered pedagogy and their views of coherence within their schools are nonetheless important because they suggest positive movement in terms of some of the underlying conditions required to positively impact teaching and learning. The slightly more skeptical views about educational technology expressed in 2017 relative to baseline likely reflect the realities of putting technology into the hands of students while also addressing various mandates associated with school improvement and accountability, the consequences of which can be greater in schools such as those served by the initiative (Dee & Jacob, 2010).

Outcomes for Schools, Teachers, and Students

The surveys measured principal and teacher perspectives on the outcomes of the Apple and ConnectED initiative for schools, teachers, and students. In the absence of achievement data in this early phase of the study, principal and teacher perception of changes in student engagement and learning over time give us some insights about how the initiative influenced students.

Principals reported that the initiative benefits their schools, teachers, and students

In both 2015 and 2017, the SRI surveys explored what principals thought about the impact of the Apple and ConnectED initiative on their schools, teachers, and students. The 2015 survey asked principals about their expectations for the initiative, and the 2017 survey followed up with questions about what principals believed had occurred after two years.[14] These analyses look at responses from the 44 principals who answered these items on both surveys, allowing for insights into how their views evolved over time (Figure 21).

At the outset, a majority of these principals agreed they expected a large impact in many areas, including school-wide climate and capacity, teacher practices, and certain student outcomes. Two years later, most principals agreed the initiative did have large impacts on technology access and teacher confidence about teaching with technology. Some of the strongest reported benefits for students (and those that came closest to meeting high expectations) were student engagement and technology skills, with relatively strong reported outcomes related to the development of students' 21st-century skills as well. In contrast, a smaller portion of principals believed the initiative had impacted teacher pedagogy and more traditional academic outcomes (e.g., the academic standing of the school and student test scores). These reports align with the change trajectory described in the theory of change, which anticipates that technology use and confidence appear first as teachers begin incorporating technology into their work, and that more traditional measures of academic success will be slower to change (Baker, Gearhart & Herman, 1990; Drayton et al., 2010; Suhr et al., 2010; Texas Center for Education Research, 2008).

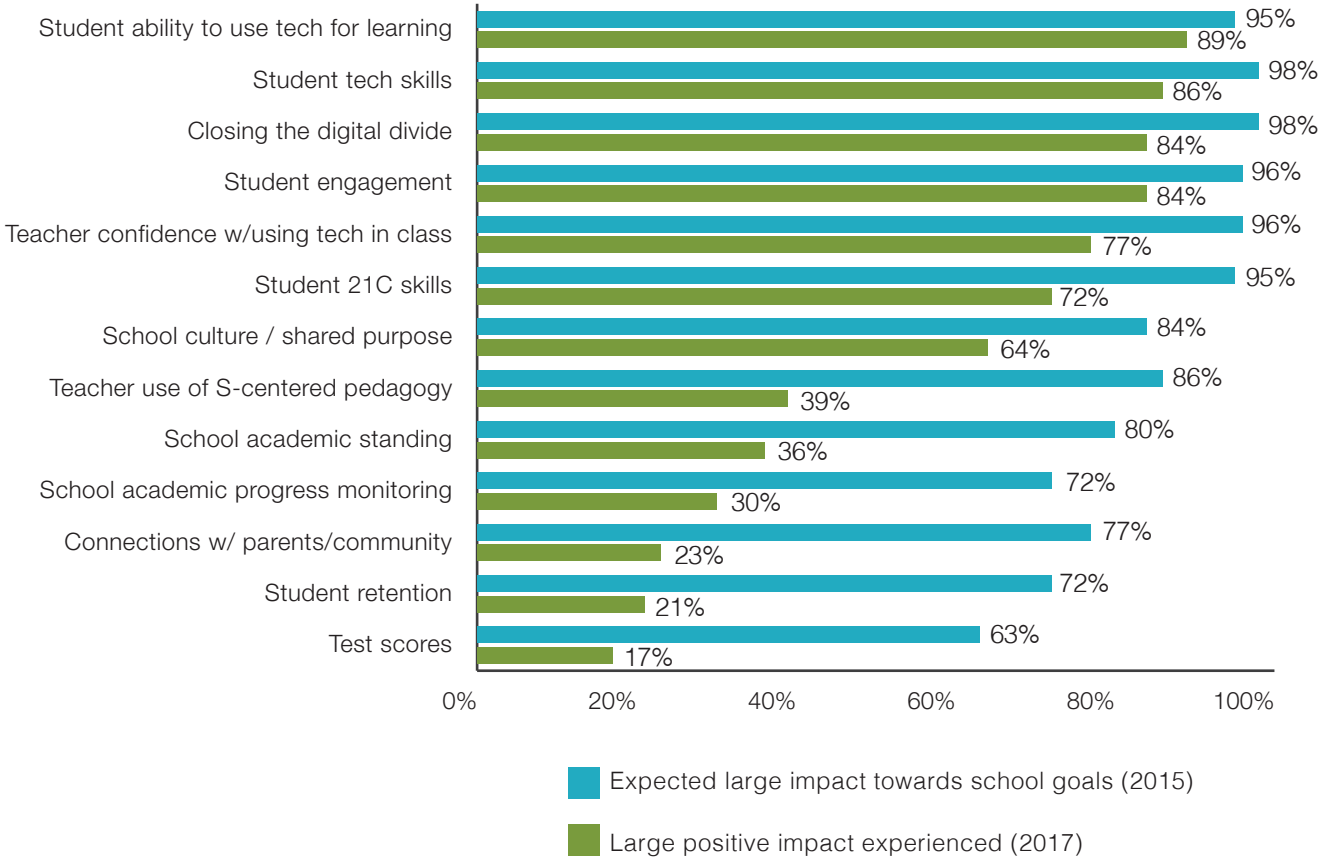
Teachers report that the initiative supports student engagement and skills

Teachers reported the Apple and ConnectED initiative greatly benefited students, particularly in the areas of student engagement, learning, and preparation for future success (Figure 22).[15] The surveys uncovered this information in two ways: first we asked teachers the same questions about student engagement, student learning, and student knowledge and skills at two different points in time (once at the baseline in 2015

14 The 2015 item read: Please indicate the extent to which you expect the ConnectED initiative will support your school's goals in each of the following areas. The percent shown here is the percent of principals reporting "large impact". Other options were: moderate, small, or no impact. The 2017 item read: Please indicate the extent to which ConnectED has supported your school's goals in each of the following areas. The percent shown is the percent of principals indicating "large positive impact". Other options were: small positive, none, small negative, or large negative impact.

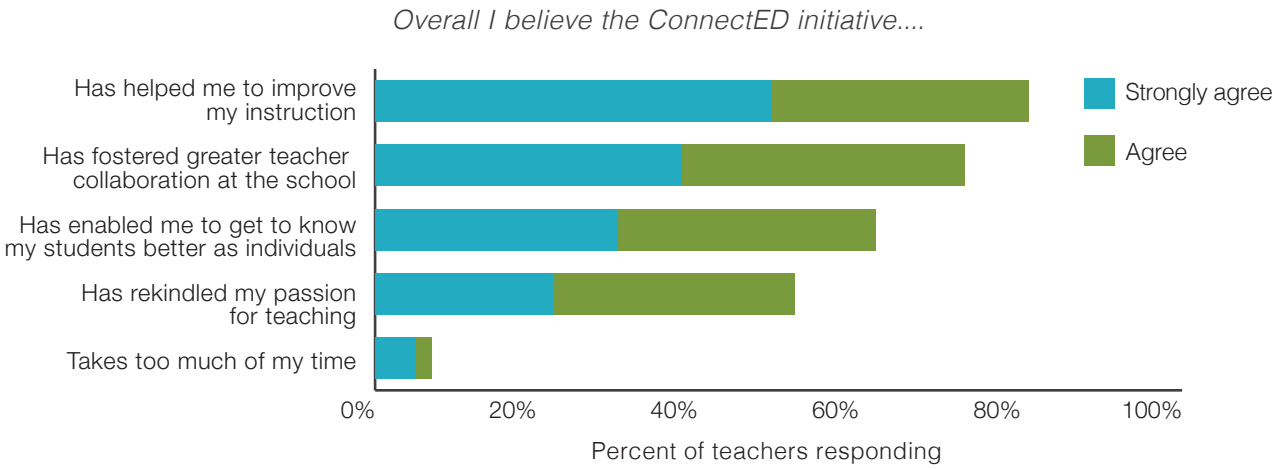
15 The survey asked teachers to place themselves on a 5-point continuum between the statements shown in the figure and their direct opposites (e.g., "Makes learning less fun for students in my classroom" for the first one).

Figure 21. Principals' expected and experienced impacts of the Apple and ConnectED initiative



Source: School leader survey 2015 & 2017 (n_{2015}=97; n_{2017}=79-82).

Figure 22. Teacher reports of the impact of the Apple and ConnectED initiative on students

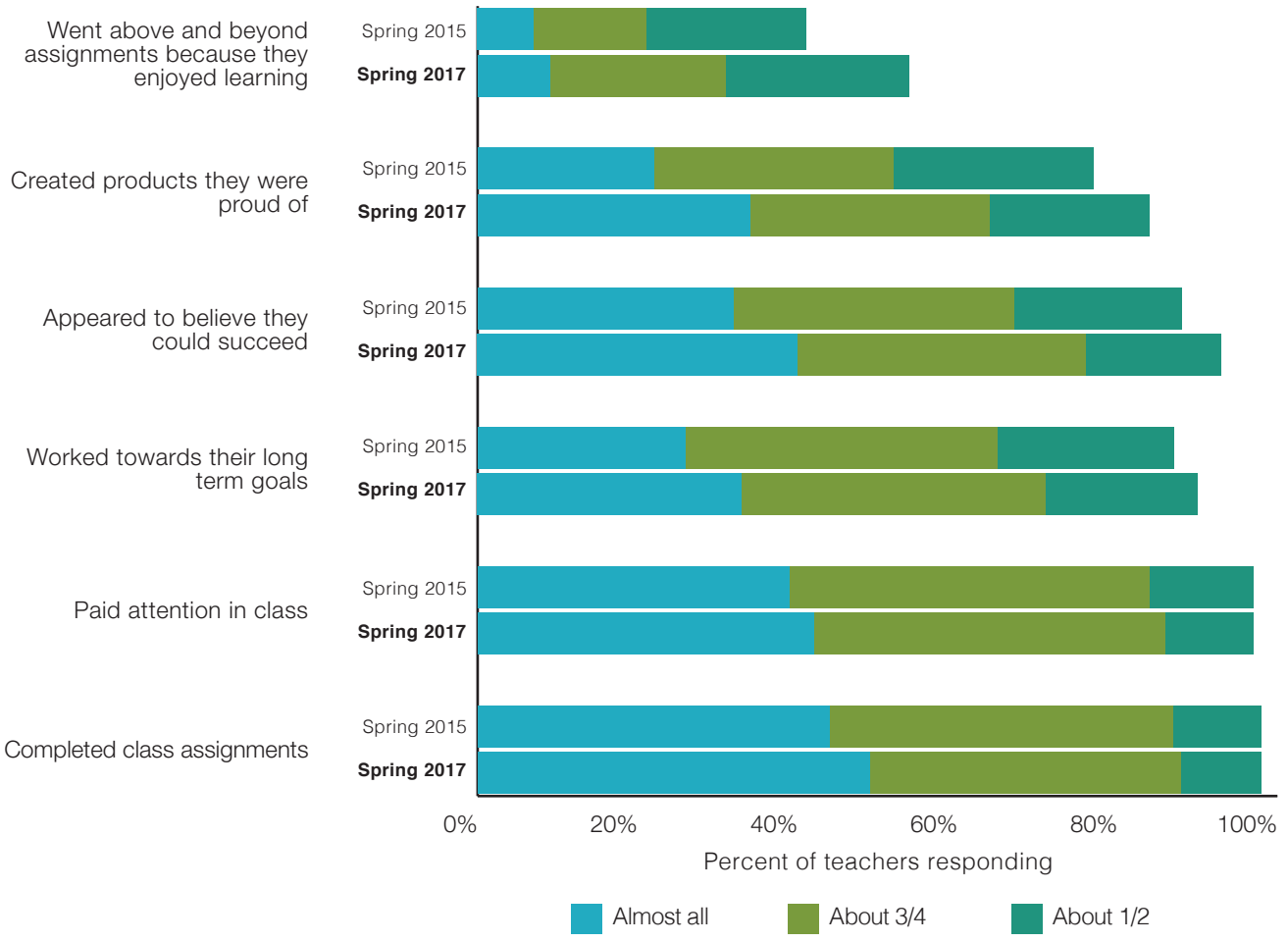


Source: Teacher survey 2017. n=2270-2321.

and once in 2017), allowing comparisons between their responses over time. Second, on the follow-up survey in 2017, we also asked teachers to tell us directly about how they thought the initiative had influenced students.

Regarding engagement, teachers reported slightly higher levels of student engagement in 2017 compared to 2015. Though small in size, the change was statistically significant.[16] Within this overall increase in engagement, we find more basic aspects of engagement (e.g., paying attention) started high and remained high, while deeper forms of engagement (e.g., going beyond expectations) increased during this 2-year period (Figure 23). These deeper signs of engagement are important because they suggest students are not merely "having

Figure 23. Change in student engagement



Source: Teacher survey 2015 & 2017. n=1235-1282.

16 The student engagement scale comprised nine items that asked about the portion of students in class who appeared to be cognitively, behaviorally, or emotionally engaged. Each item was measured on the 5-point scale from "almost all students" to "almost none of the students." The analysis sample included 1182 teachers who responded to both the 2015 and 2017 surveys. Average values across teachers were compared using a paired sample t-test with Benjamini-Hochberg adjustment, and the difference was statistically significant at p<.05. The difference was about one-fourth of a standard deviation, which is a small effect.

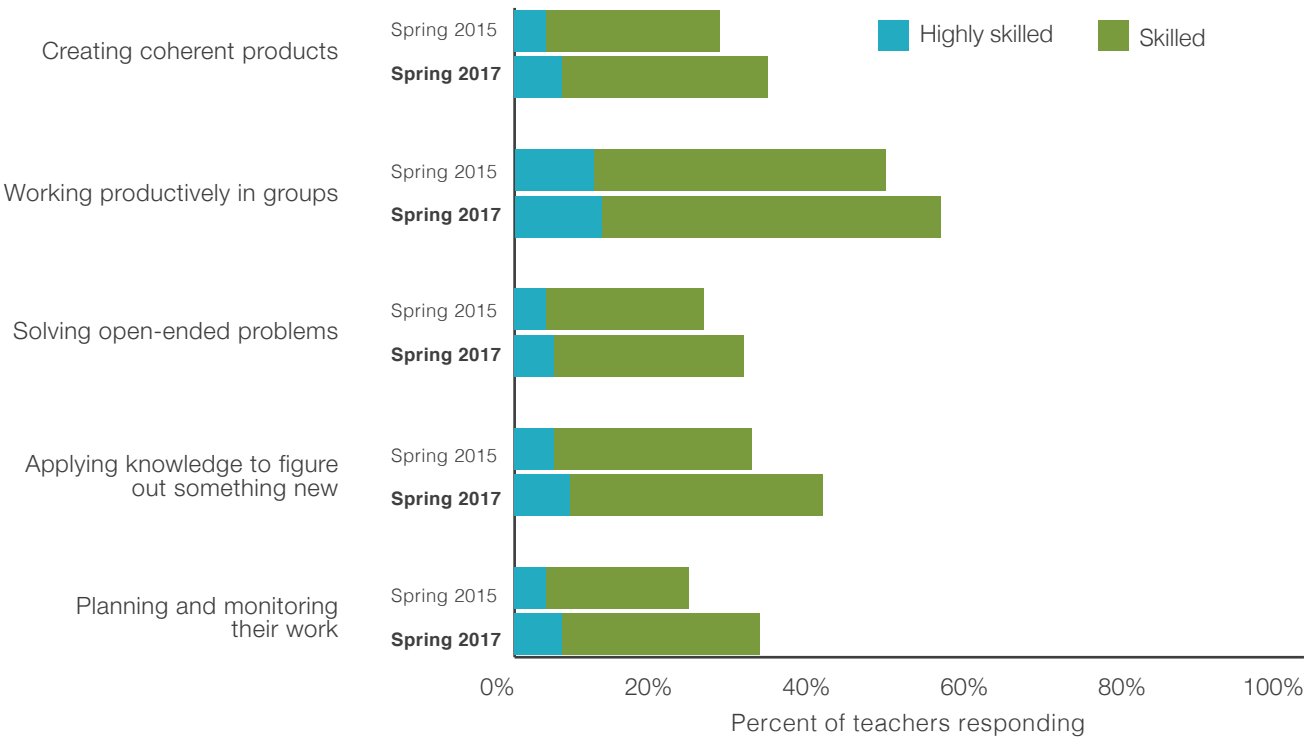
fun" with technology (as traditional "on-task" measures of engagement might suggest), but that they are becoming more invested in their learning.

Regarding skills related to deeper learning, teachers reported slightly higher levels of student proficiency across almost all skills since the initiative began (Figure 24). The one exception was solving open-ended problems, for which teacher reports of student proficiency remained stable over time. These findings align with what we know about the types of technology use and the deeper learning opportunities that students are experiencing: Thus far, experiences provided in participating classrooms have typically focused on using technology to create products and collaborate with peers; learning tasks involving open-ended problem solving and critical thinking are not yet common.

Students were enthusiastic about their experiences with the Apple and ConnectED initiative, with positive reviews about how iPads impact their engagement and learning at school

Complementing the results from principal and teacher surveys, data from SRI's student surveys offer insight into students' own thoughts about using an iPad, their experiences at school, and their learning. Overall, students were quite positive about their experiences with the iPads. However, the student survey results corroborated

Figure 24. Teacher-reported student skill proficiencies 2015 and 2017



Source: Teacher survey 2015 & 2017. n=1275-1286.

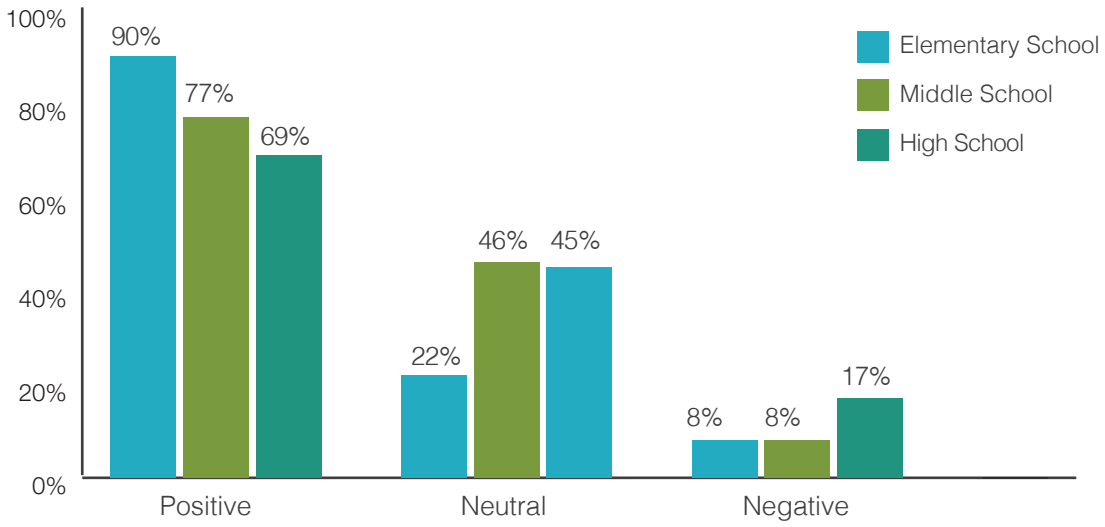
the teacher survey results, with elementary school students showing greater enthusiasm than middle and high school students.

A large majority of students used positive words to describe the experience of learning with an iPad (Figure 25). Students were asked to choose one or two words to describe iPad use from a list of 15 adjectives. The most frequently chosen word was "helpful." At the same time, about a fifth of the students selected a more neutral term such as '"okay" or "so-so" to describe the experience, indicating somewhat tempered enthusiasm about technology relative to elementary school students.

The student surveys also asked students about how their school experiences and learning had changed since they started using their iPad (Figure 26). Students believed that the iPad provided substantial benefits for them at school, with everything from engagement to collaboration to learning. One enthusiastic student reported, for example, "I never liked reading until the iPads came." Here, too, elementary school students were consistently more positive about the impacts of using iPads than their middle and high-school counterparts.

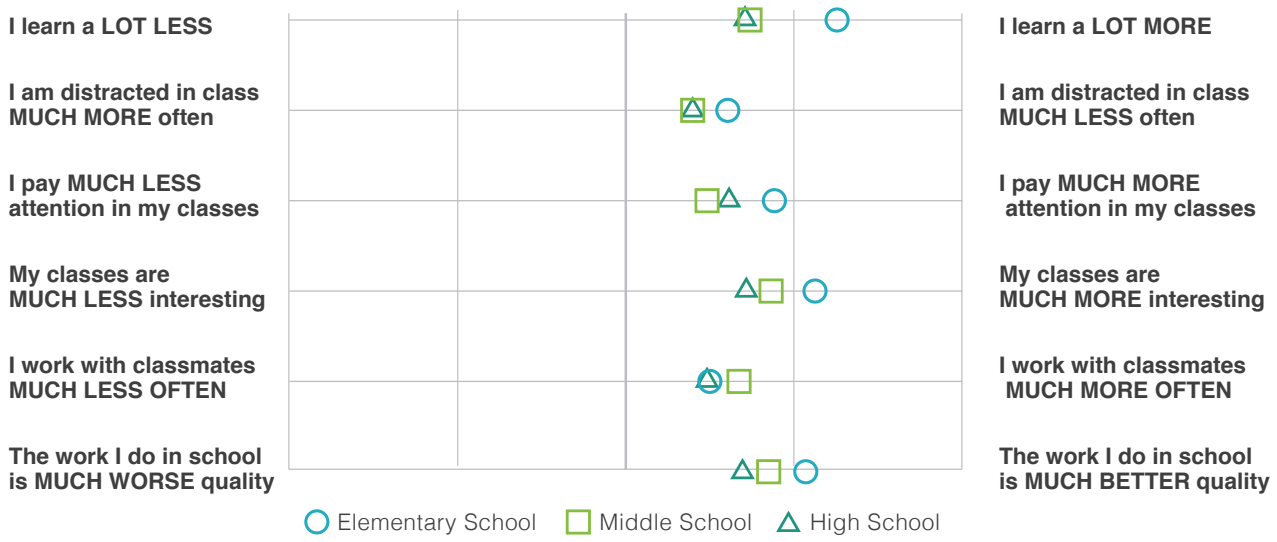
Reflecting teacher reports that the iPads enable them to personalize their instruction more than they could previously, students also reported the iPads helped teachers get to know them better as a person. Specifically, about two-thirds of the surveyed elementary school students and one-third of high school students reported that their teachers know

Figure 25. Proportion of students who selected at least one positive, neutral, or negative word to describe.learning with an iPad



Source: Student survey 2016-17. n_{ES}=841; n_{MS}=509; n_{HS}=429.

Figure 26. Students' perception of how things have changed since starting to use an iPad at school



Source: Student survey 2016-17. n_{ES}=826-847; n_{MS}=504-507; n_{HS}=429-436.

them better now than before. Students gave two main explanations for how these closer relationships with their teachers emerged:

- *The iPad provided new opportunities to express themselves, and their likes, dislikes, interests and concerns, to teachers.* One eleventh grader reported that some teachers know students better because "the work we do is more creative, which shows more of our personality."
- *The iPad allowed teachers to better understand their achievements and challenges as students.* In some cases, students reported the iPad helped teachers know where they struggled. About equally as often, students believed their iPad helped the teachers to see they are a good student—because the student was working harder and/or learning more with the iPad, or because the iPad enabled the teacher to witness the student's knowledge, skills, and motivation. For example, one elementary school student said, "Now [the teachers] can see me trying to work harder on an important assignment." A high school student reported that iPads show teachers "how much I have accomplished in learning certain subjects."

It is worth noting these are students' views of changes in how well their teachers know them. It is possible that teachers already knew their students quite well and that iPad use changed student perceptions rather than teacher knowledge and understanding. In either case, the fact that students in these classrooms feel as if they are being better recognized as an

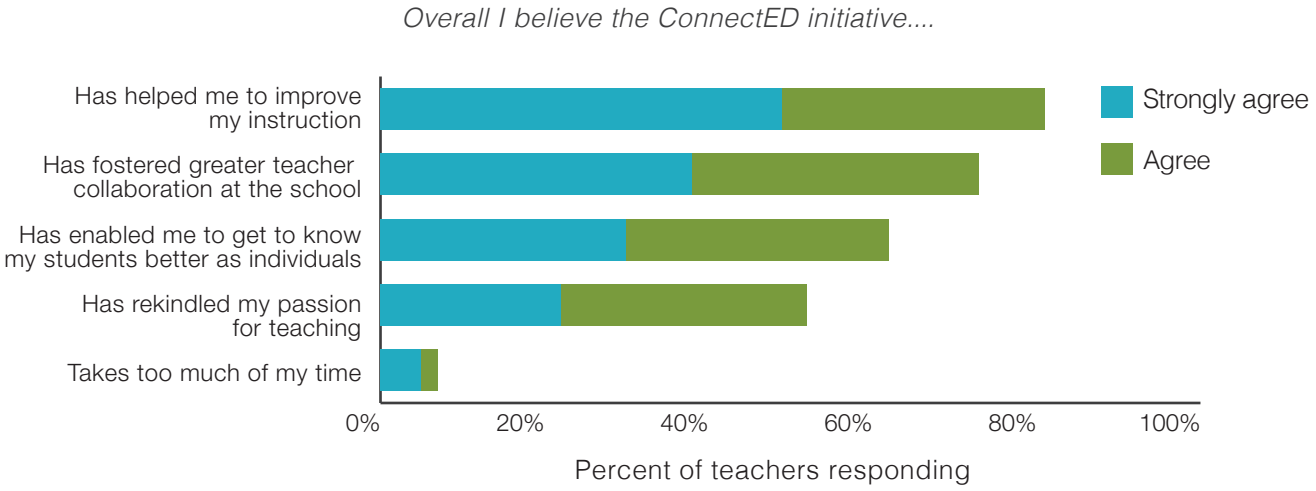
individual could have important implications for their developing sense of capabilities and identity (Erikson, 1950, 1968). Whether, to what extent, and in what ways different uses of iPads and other digital learning devices foster teacher-student connections and student identity formation would be a productive area for future research.

Teachers report that the Apple and ConnectED initiative helped them improve their instruction and fostered professional collaboration

For teachers, the 2017 survey asked how much they believed the initiative contributed to a variety of teaching and learning outcomes. Overwhelmingly, teachers reported positive outcomes from the initiative (Figure 27). Notably, few teachers found the initiative took up too much of their time, and 62% reported it freed up time for them to focus on important aspects of their job.

At the same time, the initiative supported positive changes for teachers: 81% of teachers agreed the initiative helped them improve their instruction. While this finding comes from teachers' own reports of their practices, it is nonetheless important to know that teachers believed they improved their practice. Teachers also reported the initiative helped bring about increased collaboration among staff at their school. Somewhat fewer teachers, though still a majority, agreed the initiative helped them know their students better and rekindled their passion for teaching. Decades of education reform, with and without technology, have shown us these outcomes can be difficult to accomplish, so the fact that substantial numbers of teachers believe the initiative is supporting these outcomes is important.

Figure 27. Impact of the Apple and ConnectED initiative on teachers



Source: Teacher survey 2017. n=2210-2308.

Discussion of Outcomes for Schools, Teachers and Students

The survey results demonstrate that participants were enormously supportive of the Apple and ConnectED initiative. Further, the outcomes reported by principals and teachers followed the projected change process, with proximal outcomes (like technology access, student engagement, and certain 21st century skills) emerging first, while more distal outcomes (like deeper changes in pedagogy and more traditional measures of student achievement) have yet to emerge. Looking more deeply at engagement and learning, we see patterns in how these outcomes unfold as well. In the initial year of implementation, student engagement has become deeper, moving beyond paying attention in class toward students being invested in their own learning. Teachers report that students have expanded their skills in areas like communication and collaboration, which are directly linked to some of the most common uses of the technology at this time. Broadly, these results suggest the initiative has already begun to make a difference for students at school, and they portend further advances as the initiative continues to mature.

Conclusions

The Apple and ConnectED initiative represents a substantial corporate investment in the goals of improving opportunities, in learning and in life, for students in some of the most underserved areas of the country. The initiative is premised on the belief that technology can support access to deeper learning opportunities and, in turn, improved educational experiences and outcomes for students. At the same time, the initiative holds true to an understanding that technology alone cannot create these desired changes. The hallmarks of the initiative design—a deliberately customized vision and implementation plan for each school and personalized support for leadership, teaching, learning, and technology—reflect these core beliefs and all support success at each of the participating schools.

Apple's professional learning support for school leaders and teachers formed an integral component of the initiative and provides a model for other school improvement initiatives. Apple drew heavily from their own extensive experience to design the professional learning offerings these schools received, with the goal of providing professional learning that was ongoing, hands-on, embedded, and relevant to the specific needs of the school and its teachers. These features were not lost on participants, who greatly valued the APL Specialists and reported these professional learning experiences were demonstrably different from other professional development they had received in the past. Further, those teachers who reported gaining the most from Apple's professional learning also appeared to have made the most substantial changes to their teaching practice, incorporating more innovative uses of technology and more opportunities for students to engage in deeper learning. Although all of these measures rely on teacher self-reports, the relationship between perceived value of the professional learning and observed change in teaching practice over time suggests the professional learning likely had measurable impacts on teaching and learning for at least some teachers. These findings lend credence to the initiative's evidence-based approach to professional development.

With this comprehensive constellation of support in place, the Apple and ConnectED initiative aims to effect changes to teaching and learning that will benefit students. The theory of change describes an anticipated trajectory for this process of change in educational settings that has been largely borne out over the first two years of the initiative. To begin, survey data makes clear that the initiative has met its first goal of supporting infrastructural improvements and providing access that would substantially lower important barriers to technology use. Indeed, equity of access is an important first step toward achieving equity of opportunity in these high-poverty schools.

Teacher reports of barriers associated with access and reliability have been reduced drastically since the baseline survey, and across participating schools, teachers and students are using technology regularly in the classroom.

Further, the nature of this technology use, combined with reports of the extent to which teachers are providing deeper learning opportunities for their students, suggest that some teachers are beginning to make use of the technology to change teaching and learning practices. The survey results show teachers are providing students with slightly more frequent learning opportunities in all four of the areas of deeper learning in which we can compare changes in practice over time: personalized learning, communication and creation, teamwork, and critical thinking. The largest increases came in the areas of personalized learning and the creation of products to demonstrate students' thinking—areas that current uses of technology support most directly.

Although statistically significant in the aggregate, these changes in teacher practice were concentrated in elementary schools. Middle and high schools tended to report fewer changes in practice. Other differences emerged across schooling levels as well. For example, elementary school teachers tended to maintain their initially positive attitudes toward technology to a greater extent than middle and high school teachers did, with some hesitations emerging over time for the latter groups. Similarly, while all students were largely positive about the experience of learning with technology, elementary school students were more strongly positive than their middle and high school counterparts. The different learning environments in elementary schools vs. secondary schools likely contribute to this observed variation in attitudes and practices. While all schools face accountability requirements, pressures that tend to be particularly strong in underserved schools, case studies showed that teachers at different school levels had different perspectives on how certain types of technology could align with the accountability requirements at the school. Student attitudes toward school at different stages of their lives and educational careers may also contribute to some of these observed differences in attitudes. These emerging differences between elementary schools as compared with middle and high schools are important in understanding how technology integration may transpire in different educational settings, and for thinking about the different kinds of support that may be needed at different levels of schooling.

The advances that have taken place so far throughout the initiative provide an essential foundation on which schools can build deeper changes to teaching and learning. These deeper changes—things like instructional shifts that combine innovative uses of technology and advanced opportunities for deeper learning—are precisely the ones that the theory of change anticipates will take longer to develop. As schools now enter

into a new phase of the initiative with the goal of realizing these deeper changes, both the schools themselves and Apple's professional learning offerings will need to focus explicitly on the deep integration of technology to support critical thinking and conceptual understanding. The initiative and individual schools will also need to find explicit ways to maintain the positive trajectory that has begun, even amidst inevitable turnover of key staff and other unavoidable interruptions.

For others who may be considering technology integration initiatives, the Apple and ConnectED initiative offers both lessons and new questions to pursue. The initiative highlights the importance of comprehensive, customized, and intensive support for technology integration and instructional change. As these implementations mature, on their own paths and within their own local settings, they can continue to instantiate models of what is possible within these diverse contexts and to inform important questions about the types of support that are most essential, the variety of paths to meaningful change, and mechanisms for promoting sustainability and scalability beyond initial investments.

The Apple and ConnectED initiative bears out the well-known tenet that change is hard but possible. At the 114 schools participating in the initiative, 114 unique experiences are taking shape and evolving in different ways over time. And yet, the principal and teacher surveys, with more than three-quarters of principals and teachers represented, demonstrate that certain trajectories are common as schools work to integrate technology into teaching and learning in meaningful ways. These trajectories are instructive both for the Apple and ConnectED initiative as it enters its third year of implementation, and for the field as we continue our collective efforts to support schools, teachers, and students in their mission to make the most of what technology offers for supporting greater opportunities, in learning and in life, for all of our youth.

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Appendix

Figure A1. The Apple and ConnectED initiative theory of change

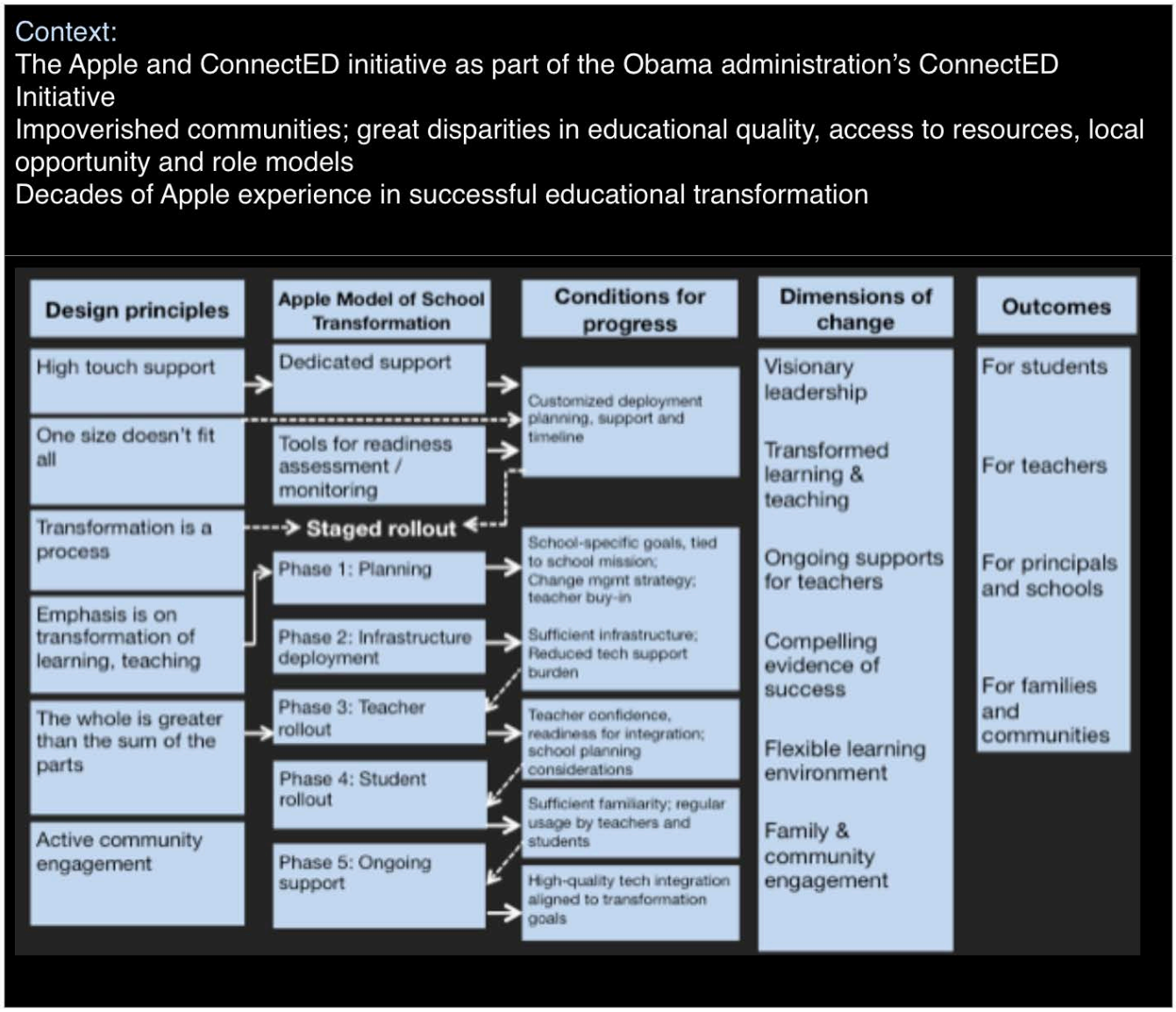


Figure A1. The Apple and ConnectED initiative theory of change (continued)

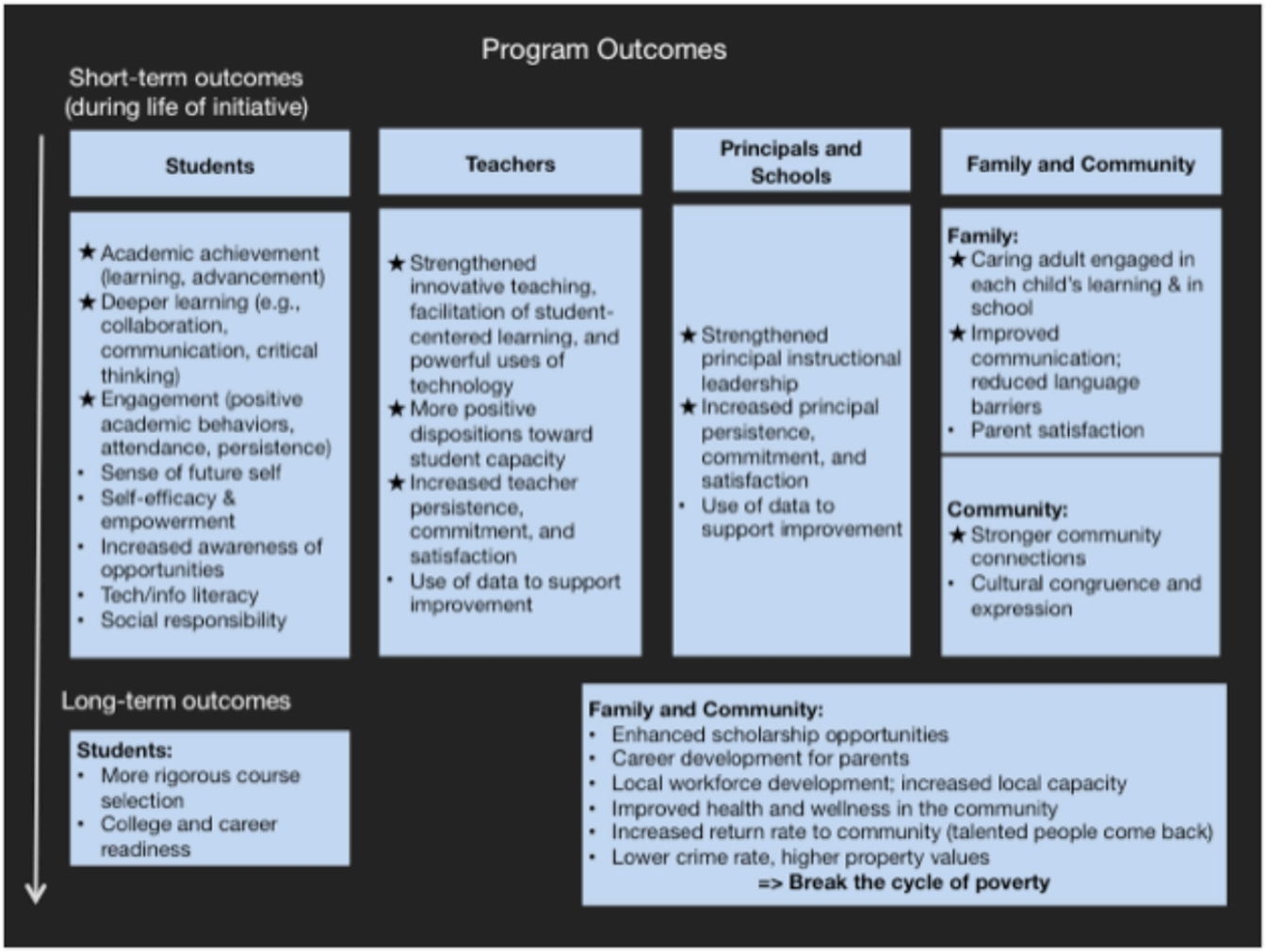
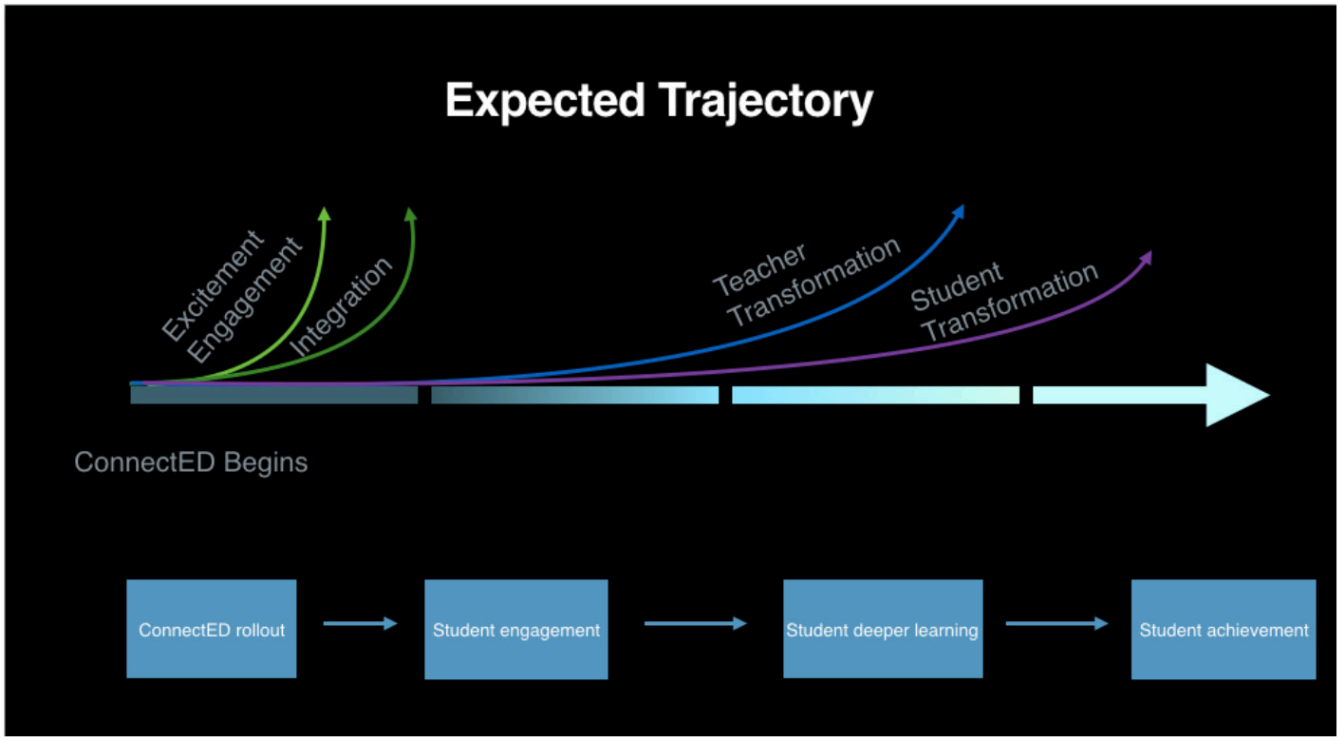


Figure A1. The Apple and ConnectED initiative theory of change (continued)



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