Encinitas Union School District
Use of Mobile Devices Research Study
2012-2013

Final Report

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Mobile Technology Learning Center • University of San Diego
A non-partisan, university-based educational research center

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This study was conducted by the Mobile Technology Learning Center (MTLC), a research entity operating under the auspices of the School of Leadership and Education Sciences at the University of San Diego. MTLC is designed to establish the university research environment of the future, while concurrently fueling innovation in K-12 education. Research projects focus on the applications of mobile learning devices to learning and tests new solutions in real-world contexts—schools. The MTLC involves collaborations with local PK-12 districts to test research findings and provide future teachers with unique teaching and research opportunities. Additional information about MTLC is available at www.sandiego.edu/mtlc.

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Executive Summary
The Encinitas Union School District (EUSD) commissioned the Mobile Technology Learning Center at the University of San Diego to conduct a study on how the use of mobile devices is affecting teaching and learning in the district. The study was designed and conducted in the second year of the district's one-to-one iPad initiative. The iPad initiative is funded by a voter-approved school bond extension intended to help the district in three areas: provide students with 21st Century classrooms, improve energy efficiency, and upgrade and renovate facilities. Providing iPads to all students in grades 3 through 6 with iPads, as well as to pairs or small groups of students in the lower primary grades, is part of the effort to create 21st Century classrooms. This study was conducted to identify the range of teacher practices and student activities and outcomes using mobile technology, and to help district administrators identify areas in which teachers need additional support.

Researchers conducted case studies of four upper-elementary classrooms in four different schools in EUSD. These four classrooms represented one Title I school and three non-Title I schools. Of the four classroom teachers, two had taught with iPads in the first year of the initiative (the year before this study was conducted), and two were in their first year of teaching with iPads. All students had used iPads in class the previous year. Researchers observed teaching and learning in these four classrooms for three-day blocks at the beginning, middle, and end of the school year. During these blocks, researchers interviewed students and teachers. In addition, researchers held a focus group interview at the end of the year with ten teachers from a fifth district school. Finally, researchers twice interviewed the EUSD Superintendent, Assistant Superintendent of Educational Services, and Director of Instructional Technology. These data were compiled and analyzed to provide a comprehensive picture of the range of teaching practices and student outcomes currently present in the district, as well of as the contextual factors that shape these practices and outcomes.

Along with a detailed description of the study, this report elaborates on the following seven findings that emerged from the data:

1. Veteran teachers want "proof" that using iPads will enhance learning in tangible ways.

2. Teachers' sense of urgency and commitment to time-on-task strongly affects their decisions about if, when, and how to use iPads, as well as the student outcomes observed.

3. Using the tool well results in better teaching.

4. Teachers demonstrate different levels of TPACK in different content areas.

5. iPads are supporting the development of the "4 C's" and other 21st Century Skills in the humanities but not in math.

6. Teachers report that professional development resources are available but challenging to access because they require use of personal (and unpaid) time. Teachers suggest that

they learn most from protected and sustained opportunities for collaboration with other teachers.

7. District administrators' priorities for the pedagogical transformation to be spurred by mobile technology include blended learning, project-based learning, and differentiated instruction. Teacher practice suggests a need for continued clarification of and support for these goals.

Following the discussion of each of these findings, the report presents three needs and recommendations for the district:

Need #1: A tool that can help assess teachers' needs, differentiated by content area.

Need #2: A more robustly unified district vision of the transformation to be achieved using mobile technology.

Need #3: An even-more transformed and transformative model of professional development.

Introduction
In order to help administrators at Encinitas Union School District (EUSD) better support effective teaching and learning using mobile technology, researchers from the Mobile Technology Learning Center (MTLC) at the University of San Diego conducted a study in the district during the 2012-2013 school year. The study examined how, in the second year of the EUSD iPad initiative, the use of mobile devices is affecting teaching and learning in district classrooms. Consisting of four in-depth case studies, the research was designed to help district administrators better understand the range of teaching practices and student activities and outcomes in classrooms where iPads are being used.

Research Questions and Methodology
This study was designed to answer four key questions about classrooms currently using mobile technology for student learning in EUSD:

1. What approaches and practices are teachers using with the technology?
2. What types of activities are students doing with the technology?
3. Do student activities seem to support content learning and/or other academic goals developed by the teacher?
4. Which teacher goals, approaches, and practices are associated with different student learning outcomes?

To answer these questions, researchers conducted four in-depth case studies that would provide insight into the specific teaching practices and student activities and outcomes currently present in the district.

Researchers carefully selected four EUSD classrooms that would represent differences in school Title I status, student grade level, and teacher levels of experience with mobile technology in the classroom. Student experience with iPads in the classroom was kept constant; all students (except for those who attended a different school in the previous academic year) had used iPads in their classrooms the year before this study. Since some EUSD teachers had used iPads the year before the study, researchers planned to sample teachers with and without iPad teaching experience in the previous year. District administrators provided a list of teachers, including the above characteristics as well as the level of teachers' interest in participating in the study. From this list, MTLC researchers spoke with and visited the classrooms of teachers who were highly willing to participate in the study. The initial goal was to select four teachers, including two Title I teachers and two non-Title I teachers; each group would include one teacher in his/her first year of teaching with iPads and one teacher in his/her second year of teaching with the devices. Because of the small number of Title I teachers in the district, it proved difficult to find two Title I teachers who met the necessary criteria. The final group of teachers, then, consisted of one Title I teacher in her[1] second year of teaching with iPads, and three non-Title I teachers, one with prior iPad teaching experience and two in their first year with the

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[1] All teachers' names and grade levels have been changed, and all are referred to as "Ms." in order to protect their confidentiality.

device. Two were fifth-grade teachers and two were sixth-grade teachers. Together, the teachers represented four different EUSD schools.

Once the classrooms had been chosen, researchers worked with teachers to schedule a series of three data-collection periods, at the beginning, middle, and end of the school year. During these data-collection periods, each consisting of three consecutive days, researchers gathered information from the following sources:

- Observations of students and teachers working on assignments both with and without iPads. The purpose of the observations was to capture the instructional focus of lessons, the range of classroom activities, and the student learning outcomes associated with each assignment.
- Interviews with the classroom teacher. The purpose of the interview was to capture the teacher's reflections on the observed lessons, beliefs about and approaches to using iPads in the classroom, goals for instruction, and plans for and reflections on the use of iPads at that point in time.
- Interviews with students working on specific assignments with mobile devices during the assignment period. The purpose of the interviews was to capture students' understandings, beliefs, and perceptions of the current assignment/task and perceptions of the content and skills being used or developed through the assignment.
- Samples of student work on the observed assignments. The purpose of examining these work samples was to identify the range of student work and to seek out links between teacher practices and student learning outcomes.

In addition to these interviews and observations, researchers interviewed EUSD's Superintendent, Assistant Superintendent of Educational Services, and Director of Instructional Technology at the beginning and in the middle of the school year. These interviews were intended to capture administrators' goals for iPad use, plans for supporting teachers and students with iPad use, and reflections on the success and challenges of the mobile technology program at this point.

Finally, in order to gain a broader understanding of the range of teacher experiences in the district, researchers conducted a focus group interview with ten teachers, representing grades three through six, from a fifth school in the district. This interview took place during the end-of-the-year data collection period.

After each data collection period, researchers used qualitative data analysis software to code and analyze the data collected through observations and interviews. This approach allowed us to understand teaching and learning practices at each time point, and to see what changes were occurring over time in each classroom. Data from each case study were also analyzed comparatively with data from the other three case studies, helping us to understand how differences in teachers' prior iPad teaching experience, as well as their unique classroom contexts, affected their approach to teaching with mobile technology.

As explained above, we intentionally selected a small set of individuals to focus on during this study in order to gather more in-depth information from each. Since only a small sample of teachers and schools were included in the study, we do not know whether the findings identified from this study capture the experiences of all teachers and students across the district as a whole. However, we have carefully presented findings that are supported by multiple forms of evidence and consistent data. We are confident that these findings accurately represent the experiences of at least a subset of teachers and students in the district.

Theoretical Frameworks

Two main theoretical frameworks proved useful in analyzing the data gathered in this study. The first of these is the Framework for 21st Century Learning, developed by the Partnership for 21st Century Skills (P21). This framework (see Figure 1) was useful for the present study because one of the district's stated goals for using mobile technology is to advance students' development of 21st Century Skills. Researchers specifically referred to the list and definitions of 21st Century Student Outcomes (available online at http://www.p21.org/storage/documents/P21_Framework_Definitions.pdf), and coded observation data to determine which of these outcomes were being addressed by teachers and/or achieved by students in the focal classrooms.

Figure 1. 21st Century Student Outcomes
Source: www.p21.org
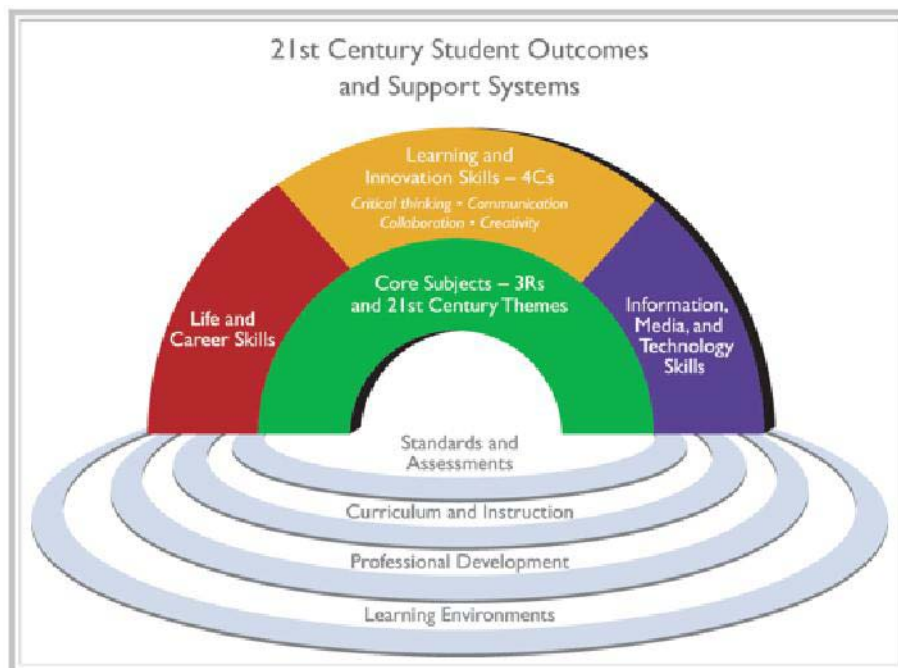
The second useful framework, illustrated in Figure 2, is Mishra and Koehler's (2006) model of technological pedagogical content knowledge (TPACK). This model builds on Shulman's (1986) model of "pedagogical content knowledge," which conceptualizes good teaching as

occurring at the intersection of strong pedagogical knowledge and strong content knowledge. The TPACK model adds the technology component to this model, and conceptualizes good teaching with technology as occurring at the intersection of technological knowledge, pedagogical knowledge, and content knowledge. In other words, to be a good teacher with technology, one must know how to use technology to teach the content to a particular group of students. The TPACK model provides a useful framework within which to analyze teacher practice and district professional development efforts. We used this framework for coding both observation and interview data.

Figure 2. Technological Pedagogical Content Knowledge (TPACK)
Source: http://tpack.org
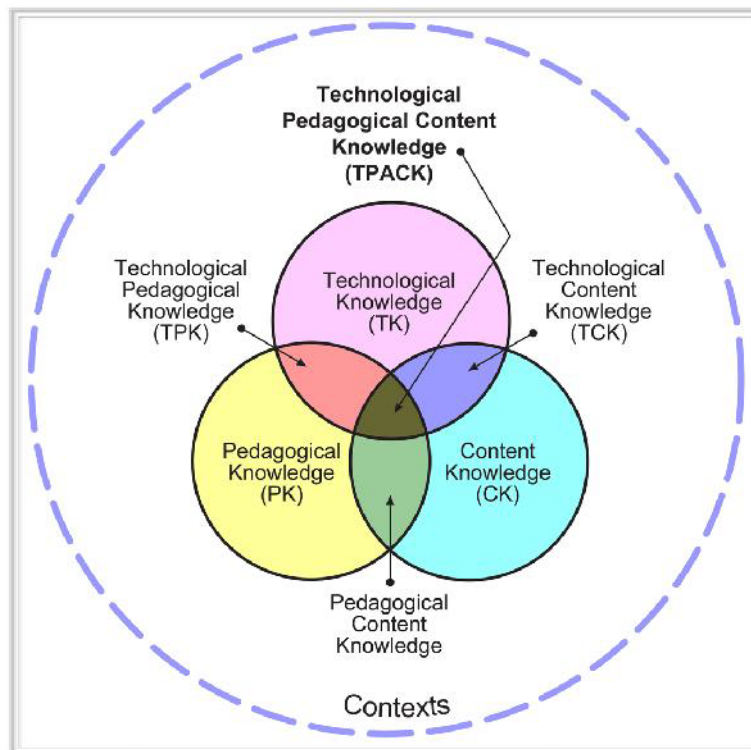
Findings
From the data, we identified six major themes:

1. Veteran teachers want "proof" that using iPads will enhance learning in tangible ways.

2. Teachers' sense of urgency and commitment to time-on-task strongly affects their decisions about if, when, and how to use iPads, as well as the student outcomes observed.

3. Using the tool well results in better teaching.

4. Teachers demonstrate different levels of TPACK in different content areas.

5. iPads are supporting the development of the "4 C's" and other 21st Century Skills in the humanities but not in math in the district.

6. Teachers report that professional development resources are available but challenging to access because they require use of personal (and unpaid) time. Teachers suggest that they learn most from protected and sustained opportunities for collaboration with other teachers.

7. District administrators' priorities for the pedagogical transformation to be spurred by mobile technology include blended learning, project-based learning, and differentiated instruction. Teacher practice suggests a need for continued clarification of and support for these goals.

These themes relate to teaching practices, student activities and outcomes, and district approaches to professional development. We elaborate on each of these themes below.

1. Veteran teachers want "proof" that using iPads will enhance learning in tangible ways.
Three of the four teachers in the case study classrooms are veteran teachers, each with fourteen or more years of teaching experience. This reflects the overall demographics of EUSD teachers, who tend to have many years of teaching experience and to be older on average than teachers in other districts. Although there were many differences between the three veteran teachers' pedagogical approaches, teaching styles, and classroom contexts, these three teachers all described having initial or persistent concerns about whether the iPad would bolster students' learning in tangible and meaningful ways. These three teachers' experiences are described below, with an emphasis on their search for proof of the iPad's efficacy as a teaching and learning tool.

Ms. Brooks, in her first year of teaching with iPads, told us at the beginning of the year that she really wanted to know whether this tool would enhance teaching and learning in her classroom or whether it would prove to be a waste of valuable learning time:

> Most importantly, I want to see how this impacts my student learning. Not just, 'Oh, this is a cool device and it's so fun and it's better than paper-pencil…' What are they really doing because of this that they weren't able to do in the past?

Similarly, Ms. Kerrigan, now in her second year of teaching with iPads, described an initial uncertainty about the value of mobile devices in the classroom.

These teachers' reluctance to immediately embrace the iPad initiative was coupled with a strong sense of confidence in the effectiveness of the teaching practices they were already using with their students; indeed, there was a strong incentive to continue teaching as usual rather than risk wasting teaching and learning time on what could, in their minds, amount to an educational fad.

Over the course of their first year with the iPads, and during the course of our study, both Ms. Brooks and Ms. Kerrigan found a powerful source of proof that the iPad did in fact substantially enhance teaching and learning: their own practice. By the winter, Ms. Brooks reported that the iPad was helping to transform and expand her capacity as a teacher, particularly in terms of differentiating instruction. Ms. Kerrigan reported that before the end of her first year with the iPads, she had found that the iPad was facilitating such an improvement in students' research and writing skills that she "would never look at a fifth grader the same way again." Having found proof, both these veteran teachers continued to modify their time-tested teaching practices and to incorporate the iPad into more aspects of their teaching. For example, at the end of her first year with the device, Ms. Brooks described how she had completely changed her approach to teaching a science unit on the periodic table; rather than simply reading the textbook and reporting on what they learned about the elements, students now used a variety of iPad apps to research three specific elements and then choose a creative way of having the elements "introduce themselves" to the class. Student engagement and learning were higher than ever before, she said. Ms. Kerrigan, whose democratic classroom culture often got the students involved in shaping their own learning, reported that her own discovery of the endless ways in which using iPads could genuinely improve lessons had become something of a joke between her and her students:

> Last year I would say, 'I really don't think there's any way we can use the iPad with *this* lesson.' At first, I was really serious. I really *didn't* think there was any way. And then it got to be kind of a joke that I would say that. And they would find some way to elevate the whole lesson, you know. It was just really interesting because of all the ways you can use it. And they would say, 'Wait a second! We can get this and this and this, and then we'd be able to do this!' So...it was a serious statement at the beginning and ended up being a kind of joke and challenge to the kids.

Indeed, we saw the iPad incorporated into many aspects of classroom life for these students. Non-fiction reading, which Ms. Kerrigan said used to be challenging for students, had been invigorated by ready access to a multitude of contemporary, kid-friendly news media relevant to their interests. Rather than simply talk about their out-of-school lives, students now brought in iMovies showcasing their talents, trips, and families. Rather than just file away corrected assignments, students now reflected on their scores and effort by using Edmodo to communicate with their teacher.

In contrast, Ms. Kelley, now in her second year with iPads, reported that although she and the students had enjoyed using the iPads the previous year, she was unconvinced that the device was helping her to achieve her bottom line: improving students' mastery of basic skills, for which she and they would be held accountable through standardized tests. Having iPads in the classroom provided students with opportunities to do creative work, she said, "but we're responsible for those test scores at the end of the year." Because of this tension, Ms. Kelley said that she felt most confident about using the iPad applications that helped students practice math facts, memorize vocabulary words, or submit responses to reading comprehension questions. Compared to Ms. Brooks and Ms. Kerrigan, Ms. Kelley's use of the device was less sophisticated and less integrated into curriculum. As we will

discuss further in the Recommendations section, district administrators may find it fruitful to proactively support the "search for proof" among veteran teachers in different school contexts as well as with different levels of technological pedagogical content knowledge.

The veteran teachers who participated in the focus group echoed these three teachers' concern about whether the device would meaningfully improve teaching and learning. The majority of these teachers suggested that they were seeing positive results and were excited about continuing to learn how to use the iPads in more effective ways. However, they also echoed another strand of the "search for proof" theme described by the case study teachers: concern about the still-not-understood effects of using mobile devices in the classroom. Both in the focus group and in the case study interviews, teachers described having important concerns about the broader implications of increasing technology use on youth. Their questions spanned a variety of topics: What about ethical, social, and safety issues that arise when elementary school students gain access to social media? What about the physical strain on young children's eyes and wrists? What about the social and health implications of spending more time on a device instead of playing outside? While most teachers recognized that these questions could not be easily answered, their awareness of these important unanswered questions likely has some impact on their choices about how and how much to use the device in the classroom. District administrators may find it useful to provide teachers with protected time and resources with which to explore and discuss these issues with colleagues and experts in the field.

2. Teachers' sense of urgency and commitment to time-on-task strongly affects their decisions about if, when, and how to use iPads, as well as the student outcomes observed.
One major difference between the four classroom environments we observed was the teachers' sense of urgency and commitment to time-on-task. In two of the classrooms, teachers consistently demonstrated a strong sense of urgency about accomplishing learning goals with their students. In these classrooms, students were almost always on-task, regardless of whether iPads were being used or not. Teachers demonstrated careful thought and planning about if, when, and how iPads would be used, rarely making last-minute decisions about whether or not to use the iPad for an activity. These teachers also demonstrated strong classroom management skills, providing clear guidance for students on appropriate use and handling of the iPad. For example, both teachers required that students place the iPads on their desks rather than in their laps, so that teachers could easily check in on their progress. Off-task behavior was addressed immediately in order to facilitate maximum productivity during the work block. In these classrooms, teachers seemed to achieve their objectives for the lesson, both when using and not using the iPad.

In contrast, the other two classrooms were often characterized by a significant amount of time off-task, often unintentionally facilitated by the teachers' weaker sense of urgency about accomplishing student learning goals in the allotted time. Both of these teachers seemed more flexible about when and how students used the devices, and both were more apt to let off-task behavior continue for extended periods before intervening. Both teachers also made occasional late decisions to use the device, either for whole-class activities or as optional activities for students who had completed other tasks. In one of

these classrooms, the teacher was very enthusiastic about using the iPad as much as possible, and indeed students used their iPads very frequently, but the value of the assignments and of the device was difficult to gauge because students were consistently distracted or off-task. Compared to other two teachers we observed, both teachers seemed to have more difficulty meeting their objectives for lessons, regardless of whether or not they were using the iPads.

Related to this finding was the issue of student engagement. Teachers in the case study interviews and in the focus group interview reported that simply using the iPad often increased student engagement. For example, young students who were not interested in independently reading a book were excited about reading the same book on their iPads. Our observations suggested an important corollary to this finding, however. While simply using the iPad even just as a replacement for pen and paper had the potential to increase student engagement levels, these sorts of uses also led to classroom management challenges in the absence of a strong classroom culture of time-on-task. For example, using the iPad Sketchbook instead of white boards sometimes resulted in students spending time changing colors and paintbrush tips rather than solving math problems. The most powerful examples of engagement stemmed from well-designed, interesting, meaningful lessons in the context of strong classroom management. As Ms. Kerrigan noted in discussing the outstanding research and writing that she had seen students do with their iPads, the results she had seen from students did not just appear because they were using iPads; rather, she, as a skilled practitioner, had designed the kinds of learning experiences that enabled students to produce excellent work using the technology. Speaking of her own development as an educator as well as of the district's professional development efforts, she said, "I hope we don't just focus on the tools, but we focus on the delivery."

The implications of this finding are fairly clear: teachers' sense of urgency and classroom management skills play a large role in determining how effectively they and their students can use mobile technology to achieve learning goals. This finding relates to teachers' TPACK, which will be discussed further in the Recommendations section.

3. Using the tool well results in better teaching.
Across the four case studies, we found that although teachers were teaching similar content and/or using similar applications on the iPads, differences in specific teacher approaches led to significant differences in student outcomes. One example of this relates to the use of IXL Math.

IXL Math was used in every classroom on almost every day we observed. However, there were two distinct ways in which the tool was used. In three classrooms, IXL Math provided a quiet independent activity that students completed while teachers checked homework, took attendance, or conducted other administrative tasks. All three teachers described appreciating the data generated by this program, explaining that it both gave students feedback as they worked and allowed teachers to easily check in on students' progress. During observations, however, we did not observe these three teachers using that data while students worked.

In the forth classroom, however, the teacher not only described highly valuing the real-time feedback offered by the program, but also used that data to provide students with differentiated support while they worked. She reported that this tool had transformed her ability to provide differentiated math instruction to her students:

> The great thing about IXL Math for me is [that it is] unlike working out of the math book, where I don't usually know until they finished maybe ten problems if it's wrong. This way I can sit with my laptop and I can log into each student and I can see real time: they've done 12 problems, they got 10 right, they missed 2. They've done fifteen problems, they got two right, they missed thirteen. ... So then I'll go sit with him or her, I can pull up what their problem was, what their answer was, what the correct answer was, and then I'll sit and go through with them, 'Okay this is what you're doing wrong.' And usually I've found, as far as remediation, a quick RTI [real-time intervention] has been much more effective versus my math instruction in the last fifteen years—because I haven't had that real time access, because I can't get around that quickly.

Her analysis of the impact of this tool on her teaching alludes to the transformative potential of mobile technology in the classroom—if used in well-planned, meaningful ways. Simply having students use IXL may have some beneficial impact on their learning of math skills, but consciously taking advantage of the immediate availability of student data seems to transform teacher capacity. As a result, students receive immediate differentiated support. According to this teacher's report, the results are apparent in students' learning outcomes.

Interestingly, the three teachers who did not make immediate use of IXL's real-time feedback all used extrinsic reward systems to motivate students to make progress through the IXL lessons. One teacher used stickers, another gave students extra credit, and the third gave students free time to explore their iPads when they had progressed through a certain number of the online lessons. We did not observe such a system, or the need for one, in the forth classroom. Students' engagement and time-on-task appeared to be much higher when the teacher was actively participating in and monitoring the IXL work.

As with the previous two findings, this finding relates to teachers' TPACK. District administrators could harness the lessons of this finding to provide teachers with pedagogical as well as technological support when introducing new apps.

4. Teachers demonstrate different levels of TPACK in different content areas.
Up to this point, we have discussed TPACK differences between teachers. Here, we present an example of TPACK differences apparent within an individual teacher's practice. This example highlights the point that teachers' technological pedagogical content knowledge is specific to each content area; a teacher may be highly effective at using technology to teach one content area while struggling to do the same in another content area.

Ms. Kerrigan is a veteran teacher who is highly skilled in many aspects of teaching, from pedagogy to content knowledge to classroom management. Particularly in the humanities, Ms. Kerrigan's instruction cultivates her students' development of 21st Century Skills. In nearly every activity and assignment, there is a strong emphasis on developing critical thinking and communication skills, and students have many opportunities to work together designing meaningful, effective, and creative products for authentic audiences. Ms. Kerrigan says that the iPad enables her to do all of this even more effectively than she has in the past. Indeed, classroom observations confirm that her use of the iPad in the humanities is frequent and sophisticated, with powerful student outcomes.

As a math teacher working with the lower-scoring group of students, Ms. Kerrigan struggles. In this content area, her pedagogy relies on more conventional and teacher-centered approaches, and iPad use is limited in frequency and scope. In contrast to the highly engaged, empowered energy that students exude during their work in the humanities, there is a sense that these same students are frustrated or easily distracted during math. Ms. Kerrigan describes often being frustrated herself with the math class, and says that she struggles with figuring out how to use the iPad in math. Although she uses IXL on most days, she finds the program uninspiring because it does not develop the higher order thinking skills that she values.

As a highly motivated and highly skilled teacher, Ms. Kerrigan—and her students—stand to gain substantially through targeted professional development focused on developing higher-order thinking skills in math, particularly with a group of students that has struggled to master math skills. We return to this example in the Recommendations section, where we suggest a targeted approach to professional development based on teachers' individual TPACK strengths and weaknesses.

5. iPads are supporting the development of the "4 C's" and other 21st Century Skills in the humanities but not in math.
Our observations yielded many examples of teacher practices and student activities that supported the development of 21st Century Skills. These examples were heavily concentrated in three specific content areas: English language arts, social studies, and science. While we found that some teachers were more proficient than others in designing rich, meaningful lessons that developed students' higher-order thinking skills, we did see that students in all four classrooms had at least some opportunities to develop these skills in these three content areas. In many cases, the iPad provided valuable support for these activities. Most consistently, we saw and heard from teachers and students that the iPad facilitated three types of activities: research, writing, and creative production.

Students and teachers often described how much easier it was to do research now that everyone had immediate access to the Internet and to the many research apps available on the iPads. Rather than have to wait for a turn at limited desktop computers, or for limited time in the library, students could simply pull out their iPads and search for information. With this increased access, students were doing research much more often than they had in the past. As a result, teachers were much more frequently teaching students how to do

research. We often saw and heard teachers instructing students on how to determine the validity and usefulness of information they found on the Web, and on how to cite such information. These lessons helped students develop strong information literacy skills.

Students in all four classrooms used iPads when completing writing assignments. In most cases, the iPad provided a word processing tool that students could use to draft, revise, and submit their writing. In more rare cases, we saw teachers and students using online tools like Socrative to facilitate whole-class dialogue about effective writing strategies. For example, in a lesson on topic sentences, students in one class used Socrative to make an argument to their classmates about why a certain sentence was more effective than others. Rather than simply telling students "the answer," the teacher facilitated a conversation in which students had to articulate their understanding and then defend or revise it depending on their discussion with the rest of the class. Such lessons helped students to develop especially strong communication skills, since they were able to get feedback and have conversations with their teacher and peers about the effects of certain writing styles and word choices.

Even in the absence of these more sophisticated uses of the iPad, however, teachers reported that simply having 1-to-1 access to a word processing tool was very valuable because it facilitated the revision process. Students explained that they much preferred typing to writing by hand. Consistent with teachers' reports, students were more willing to reconstruct certain sections of their writing when it did not require them to rewrite the entire paper by hand. One teacher, who asked students to turn their narrative stories into "Readers' Theater," found that the assignment had been transformed by access to iPads. Now students could easily cut and paste sections of their narratives into screenplays, turning these passages into dialogue as needed. After they finished the screenplays, they could use the iPads to find music and backdrop images that they would use during performance of the screenplays. The ease of revising the document freed students to spend their extra time dialoguing with teammates about how to most effectively convey their message to their audience.

While the Readers' Theater lesson was a particularly strong example of creative production, we did see students producing creative work on iPads in every classroom. Students in two classrooms regularly used an animation program to visually define and illustrate vocabulary words. As mentioned earlier, we saw students in another classroom use the same animation program to teach other students what they had learned about elements on the periodic table. Many lessons allowed students to chose whatever creative production app they wanted in order to present their learning to classmates. For such assignments, students made Keynote presentations, movies or movie trailers, comic strips, or animations. All of these assignments helped students to build a range of 21st Century Skills: creativity, communication, collaboration, critical thinking, and media literacy. Teachers in the focus group as well as in the case studies stated that they were still learning how to help students create high-quality products, but also reported often being impressed with students' aptitude in creating entertaining, creative media.

As illustrated by the examples above, the language arts, social studies, and science instruction that we observed often emphasized higher-order thinking skills and real-life applications, employed instructional methods that cultivate the "4Cs," and included varied, frequent, and sometimes sophisticated iPad use. In many ways, math instruction was significantly different. Over the course of the year, we found that math instruction in all four classrooms tended to emphasize basic skill development and employ traditional teacher-centered methodologies. Math lessons typically involved students copying notes that the teacher wrote or projected on the board, watching a short video from the Envision Math textbook series, and then working on practice problem sets out of the textbook or workbook. Depending on the teacher's comfort level with teaching the content of the lesson, this format seemed to have varying levels of effectiveness in helping students learn and master the content. We often found that while a few students seemed confident about completing practice problems or recalling lessons from earlier in the week or year, many students seemed confused or could not remember information that the teacher had taught at an earlier point.

Although we observed students in all four classrooms using iPads during math, this use was limited to skill-practice on IXL Math. Focus group teachers, in describing their uses of the device for math, mentioned IXL and online flashcards to help students memorize math facts. Over the course of the year, we found only one exception to this rule, when a teacher asked math students to create short instructional videos using the Explain Everything app. Students worked in teams to design and record their work on the interactive white board, and then shared their videos with the class as a review of the math concept they were studying. This lesson targeted several 21st Century Skills, including creativity, critical thinking, communication, collaboration, media literacy, and information, communications, and technology (ICT) literacy. This lesson, which took place in the fall, turned out to be the only one of its kind that we observed or heard described.

Our analysis suggests that there is a strong need for professional development in math in the district. Based on our data, teachers and students seem to collectively struggle with math, and stand to benefit considerably from a strong district emphasis on transforming math education. The successes that teachers are experiencing in the other content areas could provide a valuable starting point for such work.

6. Teachers report that professional development resources are available but challenging to access because they require use of personal (and unpaid) time. Teachers suggest that they learn most from protected and sustained opportunities for collaboration with other teachers. Alongside the iPad Initiative, district administrators have worked to develop a new approach to professional development (PD) in the district. Rather than require all teachers in the district to attend frequent PD days, the district now schedules very limited mandatory days. Instead, optional trainings are offered from time to time, with both expert teachers and technology industry trainers serving as instructors. Additional resources are available online so that teachers can access them as needed. In addition to providing teachers with the information they need to incorporate iPads into their instruction, this new professional development has been intended to model 21st Century instructional

methods. The new approach has also been a response to budgetary restrictions in the wake of state-level cuts to school funding.

We asked case study and focus group teachers about their experiences with professional development around iPad use, focusing on what has been helpful and where they need additional support. The consensus among teachers was that they are largely figuring out how to best use the iPads on their own and with other teachers in their teams and schools. All teachers said that they know that the district has made certain resources available, but the usefulness of these resources is constrained by the following factors:

- Time. Because professional development is no longer offered during protected time, teachers have to use their personal, unpaid time to access these resources. Teachers described this as a major challenge; many spoke of their family responsibilities after school and during summer vacation. Since teachers already have a certain amount of school-related work to complete after school, the task of adding on professional development during this time feels onerous to many of the teachers we interviewed.

- Information overload. Teachers said that infrequent conference-style professional development, while offering them choices about the content of their training, provided too much information to digest at once. Teachers identified their preferred process for learning about a new teaching tool: watching other teachers use it in context, trying it out in their own classrooms, talking about it with other experienced teachers, and then tweaking its use in their own classrooms. Because the conference-style professional development sessions cultivate breadth rather than depth of knowledge, teachers seemed to find them only somewhat helpful.

Interestingly, teachers reported that the most helpful source of professional development around iPad use was protected and sustained time for collaboration with their peers. During the focus group interview, one teacher said,

> I actually like this kind of setup where you get together with a group of people from different grade levels and take the time to share and discuss things that are working for you. And then it actually happens where they can show you very quickly. Like [my colleague] said, it takes two or three minutes to show you how they're doing it, and show you how to do it, and then it's like, 'Viola!'

Other teachers in the group agreed. "I think it's cool where we each share an app or something," said one teacher. Another said, "I love that, because I think that would be better than a long drawn-out training. Just a group of people sharing one thing to each other."

Similarly, case study teachers reported benefitting from opportunities to talk with other teachers. One teacher's principal created time during staff meetings for teachers to discuss their own iPad use and questions. Another teacher said that she had gotten valuable ideas

when she happened to be visiting another school for a union meeting. Most teachers said they appreciated the opportunity to frequently collaborate with their grade-level team members during Wheel time. One such teacher said that since her grade-level team consisted of only two teachers, it would be helpful if the two of them could collaborate with a few of their grade-level teachers from other schools. She suggested that she and other teachers could benefit from the creation of sustained partnerships between schools, modeled, she said, on the triads currently in place for principals. Talking with other teachers would be most productive, she said, if they had the opportunity to develop supportive relationships with each other. She reported that it is difficult to feel comfortable sharing one's experiences, challenges, and questions in the context of district-wide trainings. In addition, many teachers echoed the sentiment that it is immensely valuable to watch expert teachers using the device in context, rather than simply discussing it during a teachers' meeting.

These suggestions from teachers may help district administrators design professional development opportunities that focus on teacher collaboration and sustained support for teachers' skill building. Of particular value may be teachers' description of the process that they follow in building iPad teaching skills: learning about a new teaching tool, watching other teachers use it in context, trying it out in their own classrooms, talking about it with other experienced teachers, and then tweaking its use in their own classrooms.

7. District administrators' priorities for the pedagogical transformation to be spurred by mobile technology include blended learning, project-based learning, and differentiated instruction. Teacher practice suggests a need for continued clarification of and support for these goals.
Based on interviews with district administrators, there seem to be two different visions of how a 1-to-1 computing environment could transform classroom life: blended learning and project-based learning. Along with these two visions, administrators also describe an emphasis on differentiated instruction, central to both blended learning and project-based learning.

The first vision conceptualizes mobile technology as supporting a blended learning environment in which "fifty percent of the learning takes place online, personalized." Administrators embracing this vision suggest that such an approach allows teachers to meet all students where they are at in terms of skill levels. Rather than have to teach an entire class a lesson that some students cannot access and other students have already mastered, teachers can set students up with online work that is appropriate for their individual level of skill mastery. Blended learning is particularly useful for helping students build strong basic skills.

The second vision conceptualizes mobile technology as supporting project-based learning and "engaging students through passion, purpose, and empowerment." Administrators embracing this vision suggest that a one-to-one computing environment enables teachers to give all students the research and production tools needed to investigate questions, develop solutions and products, and share their learning with authentic audiences.

Project-based learning is particularly useful for helping students develop the "4 C's": creativity, communication, collaboration, and critical thinking.

Currently, the specific blend of these two approaches seen in a particular classroom depends on teachers' individual levels of comfort with each. Most teachers seem comfortable, even if not yet highly skilled, at using programs like IXL, which support blended learning. While most teachers also seem comfortable assigning students projects, we did not observe any strong examples of project-based learning. Teachers said that although they had gotten professional development over the last few years on project-based learning, the logistics of implementing this were challenging. One teacher said that she only felt comfortable planning such work at the end of the year, after standardized testing, when there was less pressure to accomplish discrete content learning goals. Another teacher reported that although she is interested in doing more project-based learning with her students, she finds that such work is difficult in the context of a rigid and highly segmented daily school schedule. For example, students have only an hour-long science block every other day, alternating with social studies. Both content areas are conducive to project-based learning, she says, but the schedule does not allow her to provide students with extended time to work on a project over consecutive days. In order to support teachers in implementing strong project-based learning, district administrators and school principals may need to make schedules more flexible and conducive to deep inquiry.

An additional challenge to implementing project-based learning in the district may stem from a current approach to differentiating instruction. We observed teachers frequently using "Must Do/May Do" lists as a way of differentiating instruction. These "to do" lists, posted on the board, provided students with a set of suggestions on what they could do if they finished a certain assignment before their classmates. Must Do/May Do lists frequently included items like "Study for vocabulary quiz" or "IXL lessons 6 and 7." The items on the list included assignments from all content areas, not just the content on which students were currently working. While this approach fulfills an important classroom management function, and gives students choice and guidance about what to do while they wait, the practice may not be conducive to project-based learning. Like the current challenges with daily school schedules, this approach to differentiating instruction conceptualizes schoolwork as a set of highly distinct and segmented tasks. In contrast, project-based learning favors an interdisciplinary approach that emphasizes depth of knowledge. Rather than "Must Do/May Do" lists that read like to-do lists, students may benefit from a set of options on how to delve deeper into a content area, or how to broaden their understanding of the lesson at hand. Specific decisions like this can be made once the district has a strong vision of how large a role project-based instruction should play in meeting teaching and learning goals.

Needs and Recommendations
As the descriptions above illustrate, there is currently a range of teacher practices, student activities, and student outcomes related to iPad use in the district. This range includes highly effective and sophisticated use of the device, particularly by teachers who already

possess strong content and pedagogical skills. Because we know that district administrators are interested in and working hard to move *all* teachers to a higher level of practice, we present the following needs and recommendations:

Need #1: A tool that can help assess teachers' needs, differentiated by content area.
Throughout this report, we have referred to teachers' TPACK, or technological pedagogical content knowledge. We have discussed many examples of how teachers' TPACK affects the content and efficacy of their instruction with iPads. In Finding #4, we discussed how differences in TPACK can exist within one teacher's practice, as in the example of Ms. Kerrigan as a humanities teacher versus as a math teacher. Her example illustrates the need for a tool that can help instructional leaders assess and support teachers' growth in different content areas.

TPACK is a useful concept for understanding where teachers need support. Perhaps with assistance from others knowledgeable in research and professional development related to teachers' use of technology in the classroom, EUSD instructional leaders may be able to develop an assessment tool that would point to areas of weakness in teachers' TPACK for each content area. Such a tool may illuminate the need for support in particular content areas, as illustrated in the Kerrigan example; in general pedagogical areas such as classroom management; or in technological/pedagogical areas such as how to best use the data generated by programs like IXL. Equipped with this knowledge, district instructional leaders can design professional development that meets these needs. This tool would also highlight teachers' strengths, allowing instructional leaders to identify potential mentors for other teachers.

Need #2: A more robustly unified district vision of the transformation to be achieved using mobile technology.
As described in the Findings section, district administrators describe two different visions for the type of pedagogy to be supported by mobile technology: blended learning and project-based learning. It is possible for these two visions to coexist.[2] In a strongly conceptualized and articulated vision of how mobile technology can support pedagogical goals in the district, there is a place for both blended learning and project-based instruction. Indeed, this is already happening to some extent in district classrooms, as teachers use IXL Math to build students' basic math skills and an assortment of research and media production applications to help students investigate and create. Currently, the specific blend of these two approaches seen in a particular classroom depends on teachers' individual levels of comfort with each. With a strong district vision, district administrators and support staff can help teachers develop expertise in using mobile technology for both kinds of instruction, as well as determine what balance of the two approaches would best achieve district goals.

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[2] For a brief discussion on how to use mobile technology to support both blended learning and project-based learning, see http://www.edutopia.org/blog/combining-blended-and-project-based-learning.

While the district has already articulated the goal of facilitating 21st Century Learning, it may be wise to also explicitly discuss and articulate pedagogical goals and approaches for closing achievement gaps at the district's Title I schools. Research suggests that teachers in schools with more low-income students are much more likely to use computers for drill and practice types of tutorial learning than are teachers at higher-income schools. This makes sense, as Title I teachers face more pressure to show progress in building students' basic skills. However, research also indicates that heavy usage of tutorial software is, at best, not very effective at building students' basic skills, and at worst, can actually have negative correlations with student test scores. In contrast, using computers to do higher-order thinking work is positively correlated with test score improvements.[3] At EUSD's Title I schools, principals, teachers, and students may benefit from explicit discussions of these issues and others, particularly if framed by a district-wide vision of pedagogical goals to be achieved with the help of mobile technology.

Need #3: An even-more transformed and transformative model of professional development. As we discussed in the Findings section, EUSD teachers have many good ideas for what kinds of professional development opportunities would be most useful to them. These ideas include continued support for team- and school-level collaboration time with other teachers, more opportunities to observe strong teaching with iPads in actual classroom contexts, learning time built into the school day rather than during unpaid personal time, and structured partnerships in which teachers from different schools could develop long-term collaborative relationships. Here, we add two additional recommendations to the suggestions already contributed by teachers.

First, dovetailing on the recommendations made under "Need #2," we suggest that teachers would benefit from professional development that allows them to experience both blended and project-based learning. This is particularly challenging in the case of project-based learning, since it requires sustained learning time that typically does not exist in traditional professional development models. This experience may be made available to teachers through opportunities to do action research, with the guidance of teacher educators. Two of the case study teachers reported that their progress in teaching with iPads over the course of this year was strongly facilitated by their participation in this study! Simply being part of the study, they said, motivated them to use the iPad in new and meaningful ways, and gave them opportunities to reflect on those experiences. Action research projects may give teachers similar opportunities, but with more authority over the content of their inquiry. Through an approach that supports teachers as researchers and active shapers of their own practice, professional development would help engender meaningful changes in pedagogy.

Second, since the use of mobile technology is so new, teachers may thrive in a professional development model that explicitly envisions and supports them as innovators. This type of model could include not only the action research work described above, but also forums for

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[3] See Warschauer, M. (2011). *Learning in the Cloud: How (and Why) to Transform Schools with Digital Media.* New York: Teachers College Press. Pp. 8-9.

discussing unanswered questions in the field and tapping into knowledge being newly developed by teachers and researchers.   Veteran teachers in search of "proof" about the value of iPads may find this valuable, as would novice teachers who are in the process of developing their identities and philosophies as educators. District administrators already demonstrate a strong respect for teachers' ability to collaborate and innovate. Explicitly incorporating this philosophy into a new model of professional development may yield increased buy-in and enthusiasm from teachers.