Using Smartphones as Essential Tools for Learning

A Call to Place Schools on the Right Side of the 21st Century

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The authors stand by this prediction: Within five years *every* child in *every* grade in *every* K–12 classroom in America will be using a mobile learning device (MLD), 24/7. And a corollary already being seen in MLD-using classrooms: Student achievement will increase *significantly*, since time-on-task increases *significantly* when students use MLDs such as smartphones inside the classroom for curricular purposes. Furthermore, the authors present provocative evidence from classrooms in Singapore to New Jersey that Kozma is right and Clark is wrong: The medium—the MLDs—do matter very much in learning!

Introduction

1:1 (a computing device for each learner) is set to make a major sweep across America's K–12 landscape. Why? Two reasons: (1) Students and their parents are demanding that schools be on the right side of the 21st century—pencil and paper simply is no longer good enough—and (2) the cost of going 1:1 has dramatically been reduced. But, in this second wave of 1:1, we had better learn from the mistakes K–12 made during the first wave of 1:1, lest more money be spent with the same limited impacts.

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Briefly, during those 1:1 laptop days, while each and every student had access to a computer, the predominant use of computers was ***supplemental*** to the existing and relatively unchanged curriculum. That is, the same instructionalist/direct instruction/didactic pedagogy used before computers were introduced was still being used, but now computers were employed as glorified typewriters and front-ends for Google searches.

In contrast, in this second wave of 1:1—a wave that will gain momentum over the decade—where schools are reporting upwards of 30% improvement in standardized test scores, computing devices are being used as ***essential*** to the curriculum, i.e., the students use the devices from 40–70% of the school day and for periods after school as well, and the "active-learning" pedagogy emphasizes student constructive and collaborative activities (Bransford, Brown, & Cocking, 1999).

The second wave of 1:1 will not be based on laptops, but rather the computing device of choice will be a mobile device, such as a smartphone, a tablet, or a netbook. The cost of the device + network is dropping and, sooner than expected, schools will be able to make use of student-provided devices, and thus schools will not even need to provide computing devices per se—all that schools will need to provide is the Internet access (a data plan) and educational software.

In this article, we first describe the supplement to the essential conjecture, and then we give an example of how a mobile device is being used as an essential tool for learning in an elementary school in Singapore, where we are seeing significant increases in student achievement. We close with yet another conjecture, i.e., we speculate as to why mobile devices elicit such a positive response from students about learning, and we close with a prediction.

The First Wave of 1:1 Implementations: The Computer as Supplement

At about 2005, K–12 schools started to implement 1:1 laptop programs. Typically, a student would be issued a laptop computer for use 24/7. Maine funded the first 1:1 statewide program in the country. Michigan followed suit, as did schools and districts all around the U.S. While the costs were high, to say the least, the access problem was finally being addressed.

On May 4th, 2007, a day that will live in infamy for educational technologists, *The New York Times* (Hu, 2007) published an article entitled: "Seeing No Progress, Some Schools Drop Laptops." The article said that schools were not seeing increases in test scores that could be attributed to the use of the 1:1 computers, and thus schools were rethinking their expensive, 1:1 programs.

The *NYT* pointed to two reasons to explain the lack of impact: (1) There was no educational software per se—the laptops came with Microsoft Office and a Web browser—and (2) the teachers were not provided with

sufficient professional development support, i.e., by and large, the teachers were taught how to use the computers, but they weren't taught how to transform their existing paper-and-pencil curriculum into curriculum that took advantage of the affordances of the networked laptops.

Stepping back from the specifics of any particular school's 1:1 implementation, in reviewing the 1:1 studies (Livingston, 2009; Penuel, 2005) we came to see that the news article (Hu, 2007) was indeed insightful. Oftentimes, the lessons the teachers implemented used the computers as typewriters and encyclopedias; students used their word processors to write reports and used search engines to find information on the Internet. While the teachers did integrate the computers into their lessons, the lessons were, by and large, pencil-and-paper lessons with computers tacked on as a supplement. The computer-based activities took up a very small percentage of time in the total lesson.

Particularly telling was the following sort of question that teachers reported their students asking: "Do we need to bring our computers to class tomorrow?" Inasmuch as the students were issued seven-pound transportable computers, aka laptops, plus bulky textbooks, such a question was perfectly reasonable, since the laptops were not used on a daily basis.

Given the lack of professional development and given the lack of educational software, it is not surprising that the teachers created lessons that were, by and large, paper-and-pencil lessons with a little computer activity thrown in. With respect to educational software, for students there has been a dearth of provocative applications. Besides the drill-and-kill programs—Math Blasters was definitely more fun than math worksheets—the only dominant educational app was a concept mapping program called Inspiration, which spawned Kidspiration, a version for the younger crowd. Still further, educational software was not low-cost, let alone free, e.g., Civilization, SimEarth, etc., were $19.95 to $39.95 per copy. Buying a copy of each educational application for each student was prohibitively expensive.

For teachers, there has been an even greater dearth of support software. While there were electronic grade books, there has been precious little support for the teaching and learning *processes*. In contrast, 2000–2010 has been the golden era for software support for professionals—outside of K–12. Could a professional accountant do a professional job with just a spreadsheet? Could a travel agent do his or her job with just a database? Indeed, today essentially every professional employs a ***layer of professional software*** that has been designed to make that professional's job more efficient and more effective: Sales people use CRM systems—customer relationship management systems; journalists use media management systems, etc.

In sum, then, the first wave of 1:1 laptop initiatives, from 2005–2008, showed little impact on student achievement. Data did suggest that attendance was up and behavior problems were down. Motivation and engagement in 1:1 classrooms definitely showed an uptick—working with computers for the digital generation was much more pleasurable than working with pencil and paper!

Table 1. Key finding from Project RED.

How Use Technology?	Use Technology But Not 1:1	1:1	1:1 Properly Implemented
Report Increased Student Achievement	69%	70%	85%

The Second Wave of 1:1 Implementations: Computer as Essential

Project RED (**R**evolutionizing **Ed**ucation), as reported in *eSchool News*, has surveyed "nearly a thousand schools with diverse student populations and varying levels of technology integration" (Devaney, 2010). ***Table 1*** summarizes a key finding: Using 1:1 when not "properly implemented" has no more effect than using COWS (computers on wheels), computer labs, etc. Frankly, this is a huge finding, since the cost of going 1:1 is significantly greater than the cost of simply using COWS and labs. Given the Project RED findings, the cost/benefit ratio does not justify moving to 1:1—unless the school does it "properly. "

What does "properly implemented" mean? In ***Table 2***, we list, in "rank order," the "Key Implementation Factors" directly from the Project RED press release (Greaves & Hayes, 2010a,b).

Table 2. Factors from Project RED.

Rank of Key Implementation Factors

1. Intervention in classes: Technology is integrated into every class.
2. Principal leads change management and gives teachers time for both Professional Learning and Collaboration.
3. Games/Simulation and Social Media: Students use technology daily.
4. Core subjects: Technology is integrated into daily curriculum.
5. Online Assessments: Both formative and summative assessments are done frequently.
6. Student-Computer Ratio: Fewer students per computer improves outcomes.
7. Virtual field trips: With more frequent use, virtual trips are more powerful.
8. Search engines: Students use daily.
9. Principal is trained via short courses in teacher buy-in, best practices, and technology-transformed learning.

If we step back from the specifics of Project RED's findings, we see how important the daily use of computers (i.e., use various pieces of software) "in the core subjects" is. In other words, increased time on task is one of the factors that leads to increased student achievement. We do hasten to point out that factor #4 includes "… in core subject classes." The factor doesn't just say more time using the computer; indeed, there have been studies that show that more computer use leads to poorer student performance (Stross, 2010). The key is that the pedagogy driving the students' use of the computer has changed from an instructionalist/direct instruction/didactic pedagogy to one where the students are more active in their learning.

While there are doctrinaire pedagogical approaches that emphasize social-constructivism, and while Project RED is indeed mute on the exact pedagogy employed in classrooms where there were reports of significant gains in student achievement, it is our conjecture that the teachers were not doctrinaire, but opportunistic: The teachers were comfortable letting loose their reins and allowing their students to be active learners. Clearly, more research is needed to identify the pedagogies that are being used in classrooms where student achievement gains are seen in conjunction with significant amounts of time spent using computing devices.

Using the "supplemental versus essential" terminology, then, we would argue that the Project RED data support the argument that when computers are used as essential tools in the curriculum, e.g., daily use with active learning pedagogies, that is when computers "move the needle," that is when students experience increases in achievement.

Most interestingly, Project RED points out that not one school reported using all of the top six factors! The "daily use" mentioned in factors 3 and 4 continues to be a challenge. In order to use the 1:1 infrastructure daily, the teachers would need to rethink their curriculum, since their existing paper-and-pencil curriculum is based on a didactic, instructionalist pedagogy that does not lend itself to students working independently of the teacher. And, inasmuch as teachers and schools/districts have already invested in developing their existing curriculum, they are loathe to throw it out and start again. Rather, it has been our experience in dozens of schools all around the country that teachers take their existing curriculum and simply add activities that incorporate the computer, which they feel does accomplish the goal set forth by their administrators, i.e., "integrate the computer into your curriculum."

Candidly, it is not just the non-trivial cost involved in rewriting the curriculum that stops districts from doing the rewrite—and stops districts from using their 1:1 infrastructure on a continuous, daily basis. The issue goes to the heart of school change: The nature of the curriculum and the nature of the instruction will need to change if the school is going to use the computers on a daily basis. Those teachers who are already using a more project-based/problem-based/ inquiry-based pedagogy, where the emphasis is on student-centered exploration, tend to find it easier to transform their existing curriculum into one that takes full advantage of the affordances of a networked environment.

In sum, then, in order to move the needle and increase student achievement, 1:1 implementations must be "proper," according to Project RED, which means that the computing devices must be seen as essential, not supplemental. In the next section, then, we illustrate what a classroom looks like that uses computing devices as essential tools by describing how a P3 (3rd grade) class in Singapore's Nan Chiau Primary School (NCPS) has used mobile computing devices in helping students increase their achievement—their already high achievement, in fact.

Using Smartphones as Essential Tools: A Case Study

While Singaporean students tend to score quite high on international tests, Singapore's Ministry of Education (Ministry of Education, 2010) is encouraging schools to prepare Singaporean students for positions in the global, knowledge-work economy by helping them develop 21st century skills, e.g., self-directed learning and collaborative learning. One needs 21st century tools to truly teach 21st century skills, and that means 1:1. Now, the choice of device was clear: Laptops are not sustainable. But smartphones *are* sustainable, cost-wise, and smartphones are more in concert with the emergence of mobile technologies as a dominant technology in the coming decade.

Dr. Chee-Kit Looi and his associates from the National Institute of Education in Singapore (Looi *et al.*, in press) are working with Mr. Chun Ming Tan, principal of Nan Chiau Primary School and his teachers to (1) rewrite the P3 science curriculum to take full advantage of mobile smartphones, (2) implement inquiry-based pedagogical instructional strategies that support the Ministry's goals, and (3) track the impact of this change on student achievement at NCPS.

During the 2008 school year, students in P3 (3rd grade) at Nan Chiau Primary School used HTC 68000 smartphones with software that enabled the entire lesson to be presented and enacted on the smartphone, i.e., all the activities that a student undertakes during the lesson would be specified in the software on his or her smartphone. That support software was provided by GoKnow, Inc., and is called the Mobile Learning Environment (MLE); see ***Figure 1***. Some of the tiles (rectangles on the screen) are learning resources identified by the teacher for the students, and some of the tiles are learning activities that the students enact. Not all the resources and assigned learning activities are displayed on the screen; a student

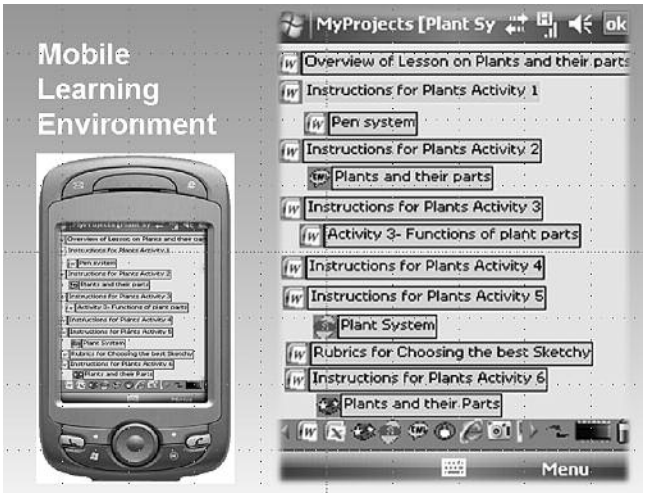

Figure 1. Plant lesson in the mobile learning environment (MLE).

Figure 2. Students using the MLE in classroom.

would scroll down to find more tiles. Tapping on a tile "opens" the tile, e.g., invokes a program such as a concept mapping program, or links to a Website.

In ***Figure 2***, we present an image from the classroom that shows how the students use their MLE-equipped smartphone (Zhang *et al.*, 2010). Various learning activities supported by software applications are shown in ***Figure 3***. For example, in the Plant Systems lesson, students are asked to create a concept map, a KWL chart, an animation, a spreadsheet, etc. The entire, multi-day lesson is represented in the MLE.

The students spent approximately 30 minutes a day, three times a week for three weeks on the plant systems unit for a total of 4.5 hours. The students were also allowed to do science when they had free time; virtually all the students took advantage of this extra time to work on their science. In addition to class time, students worked on their plant systems lesson at home. The following list gives examples of some of the activities done by students on the plant unit at home:

- complete KWL chart;
- watch videos on functions of plant parts; record the functions of roots, root hair, stems, and leaves in a table;
- take pictures of different kinds of plant parts in their neighborhoods (each group took one part of the use of Sketchy to illustrate the transport systems in a plant; and
- complete a PicoMap to summarize what they had learned for plants and plant parts.

Two issues to note about the above list:

1. ***Camera:*** Students were constantly using the camera on the smartphone to take pictures that enabled them to relate the abstract ideas in the lesson to the concrete things in the world. We have seen math teachers, for example, asking students to take pictures of things in their world outside the classroom that illustrate, say, obtuse angles. The students bring the pictures into class the next day and discuss them—why is that an obtuse angle?
2. ***Homework is schoolwork:*** What the students do outside of class is very much the same as the work they do inside of class. This observation is relevant to the issue raised below about the role of the smartphone outside of school.

Notice that because of the ease with which the students can carry their smartphone, the smartphone is available to them for their school work essentially 100% of the time during the lesson. Inasmuch as all the written (e.g., concept maps, animations, etc.) activities were enacted on the smartphone, students spent a considerable percentage of the 4.5 lesson hours using the smartphone. Now, collaboration is a key 21st century skill that Singapore's teachers are trying to help their students learn. So, in addition to working on their smartphone, the students are engaged in dialogue and other collaborative activities, as illustrated in ***Figure 2***. While ***Figure 4*** is a picture from a middle school in Ohio, it is an excellent illustration of how the smallness of the smartphone facilitates conversation and sharing.

The students in P3 at NCPS experienced a total of 21 weeks of lessons that had been redesigned from the ground up to be inquiry-based, focused on self-directed learning and collaborative learning skills, but still contained the high degree of content that is typical of Singaporean lessons. It was a challenge, quite frankly, to pack all that required content together with the focus on process skills that are supported by the use of the smartphone (Bransford, Brown, & Cocking, 1999).

Even though the students were not exposed to all of

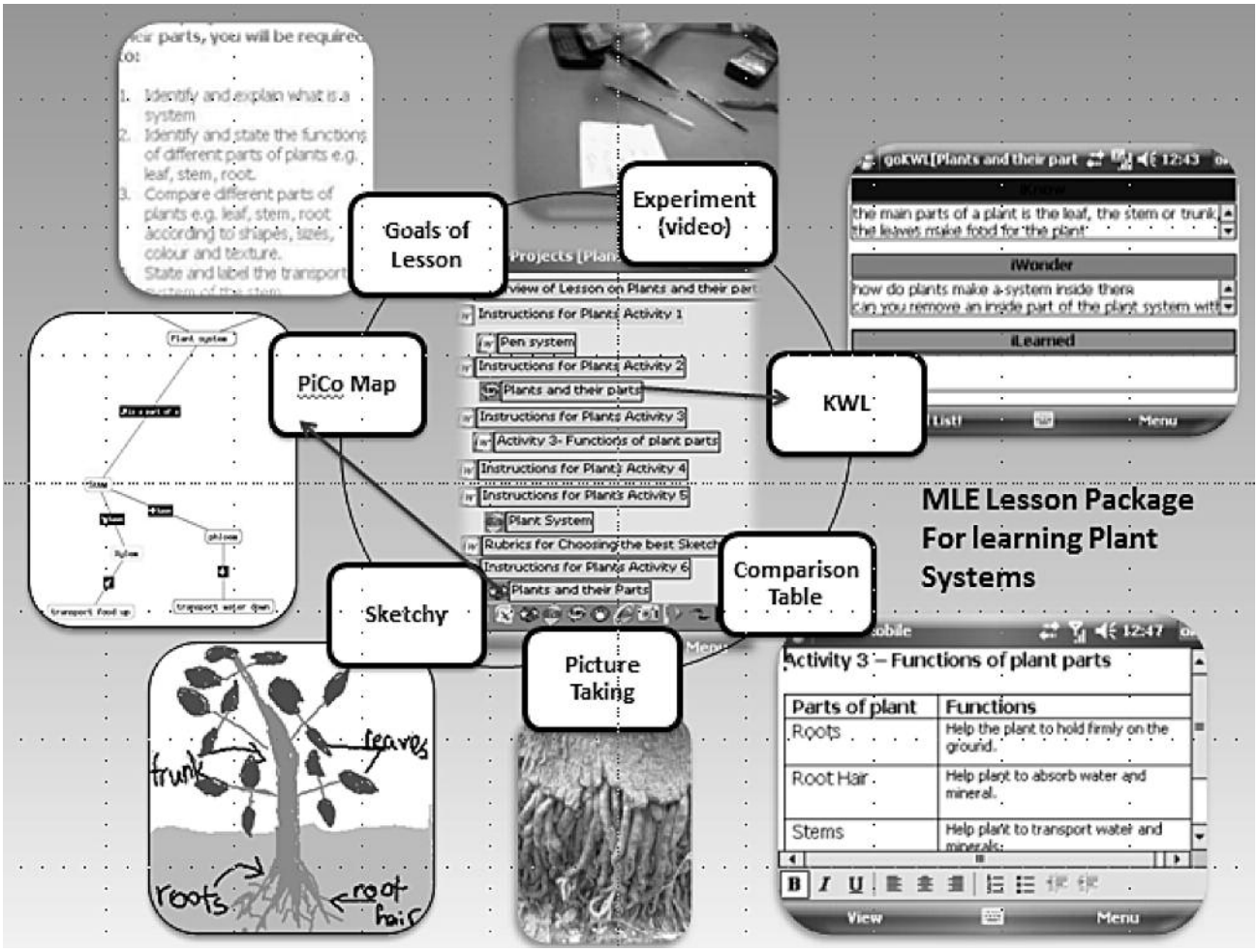

Figure 3. Sample screens from plant lesson in MLE.

the required content, the results nonetheless indicate that among the six mixed-ability classes* in Primary (Grade) 3 in the school, the smartphone-using class performed significantly better than the other five classes, as measured by traditional assessments in the science subject (Looi *et al.*, in press)

In sum, for the P3 class, their smartphone was definitely an essential tool to engage in learning about plant systems—and, using Project RED's terminology, the P3 class did implement 1:1 "properly." The lesson was created from the ground up to take advantage of the affordances of the smartphone and the software running on the device:

- from the Mobile Learning Environment, which supported the *teacher* in the process of creating a complete and comprehensive lesson and supported the *student* in enacting the lesson; and
- to the individual applications like Sketchy, PicoMap, Mobile Word, etc., which supported the *teacher* in creating engaging and effective learning activities and which supported the *students* by enabling them to engage in a broad range of interactive learning activities.

The students had access to the device essentially 100% of the time they were working on the lesson, and they used the smartphone for every artifact in the lesson. The students used the smartphone at school and outside of school. In effect, both the teacher and the students used the smartphone like a 21st century knowledge-worker—as a tool that is critical to getting their job done—where the job of a teacher is to create lessons and support students enacting those lessons, and where the job of the student is to enact the lessons provided by the teacher.

In the next section, we go beyond the Project RED framework and discuss the impact of the particular realization of 1:1. That is, while RED is neutral on what computing device is used to implement 1:1, we, for the past nine years, have been exploring the use of low-cost, handheld, mobile devices. While we started with the

* In Singapore, the top and lowest performing students are grouped into special classes; the middle students—mixed ability—are then organized evenly into classes. Our comparison groups are the other mixed-ability classes.

Figure 4. Students collaborating using smartphones.

Palm Pilot many years ago, today we are using standard-issue smartphones—since they are low-cost, handheld, and very mobile. In what follows, we identify a specific contribution that we are seeing mobile devices make above and beyond the contributions identified by RED.

The Medium Does Matter: A Conjecture

In the early 90s there was a debate between Richard Clark and Robert Kozma (Materi, 2001) about the role of the media in learning. It boiled down to this: Whether lettuce is delivered by a truck or a car, it is still lettuce. The media—be it a computer or a book—do not matter, as long as they both deliver the same content.

While there may well have been a bit of murkiness with respect to trucks and cars, there really does seem to be a considerable difference between students using laptops and even netbooks and students using smartphones. Although laptops, netbooks, and smartphones may all have the same basic functionality, e.g., one can use Microsoft Word on all three devices, there are two properties that separate smartphones from laptops and netbooks.

Portability and always-available: Since the weight and size of a smartphone is negligible, it literally fits in the palm of an individual's hand, and since toting it requires almost no conscious effort, students tend to carry them around constantly. In addition, since smartphones are relatively instant-on devices—booting up and shutting down are not painful, time-consuming procedures—the effort involved in accessing the device is for all intents and purposes zero: Essentially no effort is needed to physically take command of the device, and essentially no effort is needed to navigate to where a question can be posed.*

In contrast, toting a 2.1+ pound netbook takes a conscious act, and there is definitely a boot-up and shut-down procedure. Anderson (Tischler, 2008) has called netbooks "carry alongs"—as contrasted with laptops, which are transportable computers, and smartphones, which are truly portable devices.

Since the smartphone is omnipresent, its pattern of use is different from that of a netbook. In our classroom in NCPS in Singapore, we see children taking advantage of the fact that they always have the device in their possession to ask questions and explore other concepts in the lesson. In interviews with teachers where smartphones are being used, we hear the teachers commenting that they see the students using their devices all the time—because they can, because they are right there in the palms of the students' hands.

Respect and vindication: We feel that portability/availability isn't the only reason why students are spending more time doing their schoolwork on the smartphones. We make the following conjecture:

- Students use mobile devices outside of the classroom all the time; indeed the "kids these days" are the mobile technology generation. But schools, by and large, ban the use of mobile technologies from the classroom. Clearly, they are of the opinion that mobile technologies in classrooms are bad ("distracting, disruptive"). On the other hand, the students know that using mobile technologies outside the classroom is in fact a very good strategy for coming to understand, finding entertainment, communicating with friends, etc. The value of using mobile technologies is something the students experience firsthand—outside the classroom.
- So when schools finally say: Ok, you can use the same technology inside the classroom as you are already using outside the classroom, the students feel respected—finally—and vindicated: YES, we, the students, were right after all; mobile technology use in classrooms is indeed a good idea.
- The respect and vindication the students now feel, i.e., the acknowledgment by adults, is a strong motivator. The students are effective at using mobile technologies outside of school, and thus they can now use those same skills inside the classroom effectively on their school work. As well, the students may well feel that they need to demonstrate—to further prove—that mobile technologies are valuable, so the school won't change their mind and re-ban the devices.
- One might conjecture that this sort of emotional element would be ephemeral and wear off. Empirically, that's not what we see; we see students expending as much—if not more—time on school tasks at the end of the semester as at the beginning of the semester. The effect of using the mobile technologies is not a Hawthorne Effect.

* Individuals report enjoying the activity of making use of their smartphone (personal communications from various individuals).

Clearly, this is a conjecture; and while the anecdotes below are supportive, but provocative, our conjecture is definitely in need of substantiating evidence:

- *Toms River, NJ:* 150 fifth-graders used smartphones from February to June, 2010. The teachers and the Director of Technology claim that all 150 students did every homework assignment on time.
- *Garnerville, NY:* Every one of the 30 fifth-graders in the pilot class did all their homework—on a snow day at home!
- *Toms River, NJ:* A teacher tells the story of a parent driving his son and a friend to a Giants football game on Sunday. The boys were both in the back seat, quiet—too quiet. So the father asked: "What are you guys doing back there?" And they responded: "Doing our homework." (And they were!)
- *Watkins Glen, NY:* After an hour of 30 students showing 100+ IT directors from neighboring school districts how to use the smartphones, a 12-year-old boy asked to address the group and was given permission to do so. In front of the 100+ adults, who were virtually strangers, the lad said: "I want to thank all of the adults here for bringing smartphones into our school and giving us this opportunity to help us learn."
- *Saratoga Springs, NY:* At the rollout of the 30 smartphones to his class, a fifth-grade boy hugged the Verizon salesperson and said: "This is the way schools should be."
- *Katy, TX:* A teacher was showing parents the paragraph that their fifth-grade boy had written. The parents said: "Our boy is autistic; he doesn't write." The teacher responded: "He doesn't write with pencil-and-paper, but he does write if he is using his smartphone."
- *Garnerville, NY:* Sue Tomko, Director of Technology, paid $5,000 for insurance on the 80 phones for 2009–2010. She said she wouldn't buy insurance again since she lost just two styluses the entire school year. The loss and breakage rate of the smartphones by the students, across the dozen or more projects during 2009–2010, was phenomenally low; on the level of a few styluses typically and a few damaged screens.
- *Katy Intermediate School District (Katy, TX)* is on record as claiming an increase in test scores in the 20–30 point range for those using the devices. Comparable increases in test scores were claimed in St Marys, OH, and Toms River, NJ.*

Indeed, the stories, frankly, are endless—and at the same time provocative and implausible! All 150 students do every lick of homework for five months? On time? While there is prima facie evidence that smartphone use does appear to make a difference in the learning of K–12 students, it will take considerably more evidence to substantiate that claim.

There are real implications of our conjecture on the Clark–Kozma debate. Assume our conjecture is correct—that smartphone use, for the reasons identified above, engenders a substantial emotional pull on a student so that the use of the smartphone actually makes a difference to a student's understanding and final level of achievement. Then, those students would not perform as well in a classroom that uses laptops or a classroom that uses no technology. Laptops are not today's students' mobile technologies; rather, laptops are their parents' technologies. And, a curriculum change alone, e.g., bringing into the classroom a more active learning, constructivist pedagogy without the use of smartphones, would not engender the gains in achievement seen in classrooms using smartphones. The method of learning does matter; the instrument of learning does matter. Using a device—mobile technologies such as smartphones—in which students have a substantive emotional investment, does make a difference in learning outcomes—if our conjecture is true. Given how much is at stake, then, it certainly makes sense for the research community to explore this issue.

Concluding Remarks

Schools literally all over the world are being challenged to prepare their students for a new world—a global, knowledge-work marketplace. Countries, such as Singapore, which have traditionally scored very high on tests—tests of content, tests of "what"—are realizing that in that new world order a different set of skills is needed. Here in the U.S., where the same tests of "what" have ruled the land in K–12, recognition is dawning that we must prepare—and test—our children differently. That is, while there are items that must be memorized, we need to prepare students to understand how systems work and, most importantly, we need to prepare students to work both independently and in a team. In order to teach those 21st century skills and that 21st century content—the "how"—we can't be using tools based on 18th century pencil-and-paper.

Project RED is leading the way towards providing the proof that school districts appear to want to justify the significant effort that is going to be needed to make the shift to 21st century teaching and learning. Integral to that shift is the realization that if schools are going to move the needle—make an impact on student achievement—then using computing devices as supplemental to the existing curriculum is not going to work. As long as computing is supplemental, it will have limited impact on teaching and learning. Moving the needle requires that education use the 21st century technology as other 21st century knowledge-workers are doing, as essential tools. SETDA (State Education Technology Directors Association) in their

* Norris and Soloway are in the process of documenting these scores.

2009 Guide for Classroom Use of Computers suggests that: "computers need to be used continuously and seamlessly…" in the classroom. "Continuously and seamlessly" is more than "integrated into the curriculum" and more even than RED's "use daily."

But, as RED is seeing and as we are seeing on a more anecdotal level, there is real benefit to be gained from going 1:1 using smartphones—not only, as RED observes, do test scores go up but we see students engaging in school at a level that is unprecedented. Given that level of impact, we fully realize that much more research needs to be done before substantiated claims can truly be made. We feel that there is ample prima facie evidence to warrant the expenditure of funds to more systematically explore the conjectures raised here.

We have gone on record publically with the following prediction: Within five years *every* child in *every* grade in *every* K–12 classroom in America will be using a mobile learning device. Research can contribute by informing and shaping the implementation of these mobile technologies. RED has observed that 1:1, if not properly implemented, offers little benefit over traditional uses of technology. Research can help schools use mobile technologies effectively—and not waste resources. But, regardless of what research does, the rollout will proceed. Mobile technologies are bigger than the Internet. The Internet is a roadway; without a car, a roadway is useless. Mobile technologies are the cars for the Internet. Mobile technologies are giving voice to individuals who otherwise would have none. The momentum behind mobile technologies is unprecedented. Mobile technologies are insinuating themselves into every crevice of the consumer world as well as pushing into the business enterprise. They will even invade K–12, which has staunchly resisted change for hundreds of years. Mobile technologies are moving at bullet-train speeds! □

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