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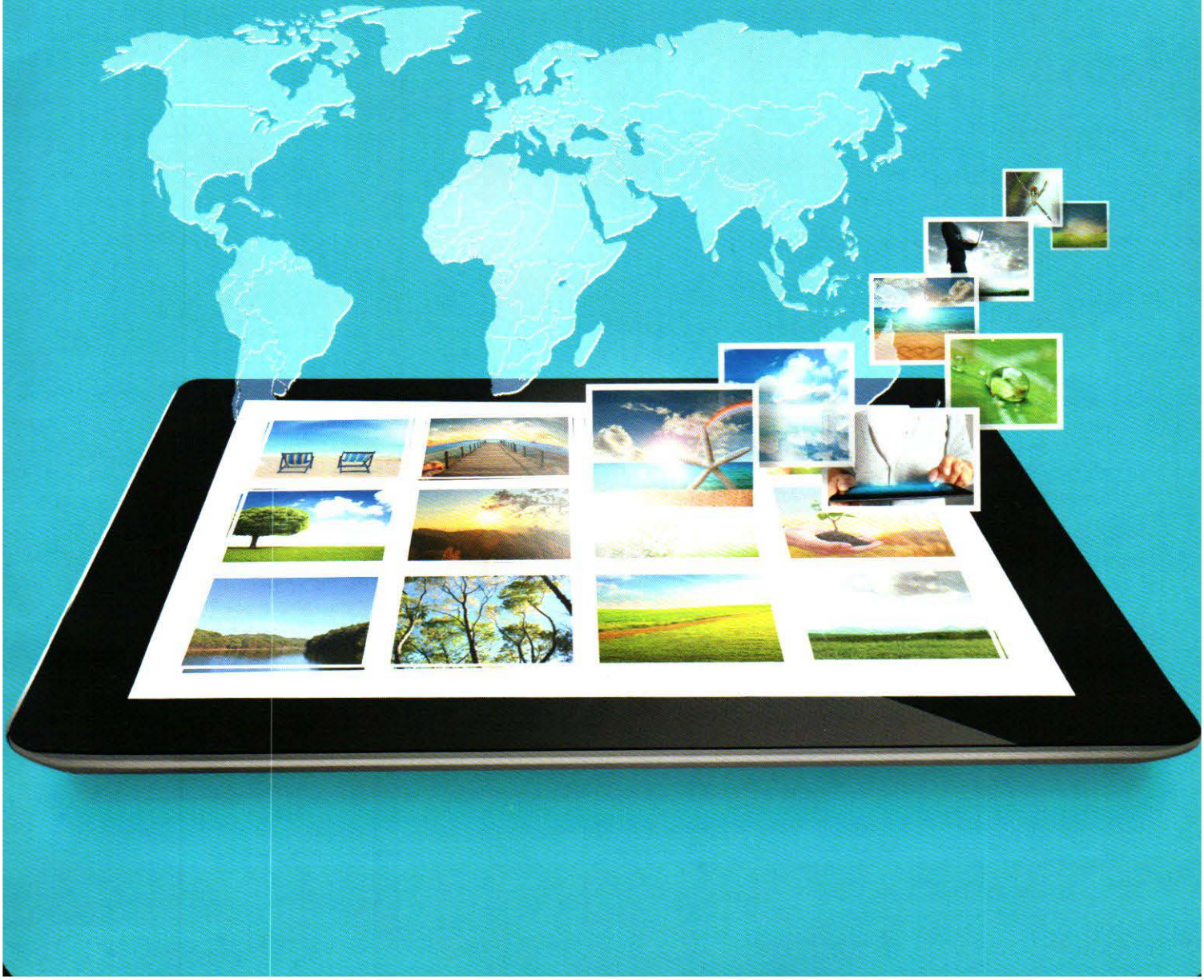

Twelve Factors Leading to Fundamental Pedagogical Change in a Primary School

A Case-Study

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A school *can* change. In this case study, the authors describe the 12 factors they have identified as being key in the transformation of the core pedagogical practices at Nan Chiau Primary School, Singapore, from direct instruction to inquiry, from a 20th to a 21st century school. While the adoption of 1:1 mobile devices played a catalytic role in the school's transformation, in order for the school-level transformation to be scaled and sustained, all the factors needed to be addressed. As the 12 factors are culturally neutral, the experiences in Singapore have relevance to the ongoing school change conversation in the U.S. and in other countries.

Introduction

"Why should I change the way I teach? Parents ask for me to be their child's teacher because my students always score high on the [high stakes] Primary School Leaving Exam." *3rd Grade Science Teacher, Nan Chiau Primary School*

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It is a well-known fact: Singaporean children score very high on standardized tests, e.g., on the 2012 PISA (Sedghi, Arnett, & Chalabi, 2013) test, Singapore was ranked second in math and third in reading and science in the world! Now, since Nan Chiau Primary School (NCPS) is a top-ranked (On, 2015) Singaporean primary school, its pedagogical practices are clearly working very well. So, ***why*** did NCPS embark on a multi-year effort to change its core pedagogy from a direct instruction, memorization, work-sheet based pedagogy to an inquiry pedagogy, where teachers and students engage in questioning and conversation, using 1:1 smartphones and tablets, as enablers for both self-directed and collaborative learning?

Baffling! If American schools had been ranked "second in math and third in reading and science in the world," folks here would be ecstatic and would not be grasping for new educational opportunities, e.g., charter schools (Pondiscio, 2015) and Common Core State Standards (Common Core State Standards, n.d.).

In this case-study of school change, then, our goal is to explain ***why*** NCPS embarked on its journey of pedagogical change, and to describe ***how*** NCPS went about making that change. To that end, then, in what follows, we describe the 12 factors that we observed have been and are being addressed in the change process. Inasmuch as the 12 factors we identified are culturally neutral, our intent in this article is to contribute to the ongoing conversation about school change in the U.S. and in other countries.

The 12 Factors

Factor #1: The Spark: Initial Cause for Change

Organisms favor stasis; there needs to be a significant spark that causes an organism to leave stasis and enter a period of turbulence. At NCPS, there were two such sparks:

Spark #1: Singapore's MoE Calls for School Change. While Singaporean schools have significant autonomy, Singapore's Ministry of Education (MoE) does set policies, standards, and curriculum to which Singaporean schools need to align. Seeing (Koh, 2008) that its schools were not preparing Singapore's children for the future, global, knowledge-work economy, MoE (Tan *et al.*, 2010) articulated a vision for its schools:

> ...It is therefore no longer sufficient to help our students achieve only the learning objectives specified in the national syllabi. Rather, learning needs to be broadened to develop students' competencies in learning how to learn...We need to foster amongst our students an acute sense of inquiry so that they are intrinsically motivated to understand things surrounding them.

Strategically, MoE (2008) saw that ICT (information

and communications technology) needed to play a pivotal role in enabling schools to change and students to become self-directed and collaborative learners, two anchoring 21st century skills. Thus, MoE instituted a series of 5-year plans to support schools in integrating ICT into their curricula, culminating in MasterPlan3, 2009 to 2014 (MoE, 2013; Ng, 2008). Singaporean schools, then, are in various stages of trying to align themselves with the goals MoE has outlined.

Spark #2: A New Principal for NCPS. Organizations oftentimes make changes when a new leader is installed. Indeed, the process of NCPS' pedagogical change dates from the arrival of a new principal, Mr. Tan Chun Ming, who moved into the top school slot in 2008. With his installation, as we describe below, Mr. Tan brought new vision and leadership—two more factors needed for school change.

Factor #2: Vision

From Singapore to Peoria, a school principal's day is filled with the minutiae of running a school. But, from our very first visit to NCPS, it was clear that Principal Tan had a vision, that he regularly communicated, and it was squarely aligned with the one promulgated by MoE:

> ...students...[will develop] competencies for self-directed learning and collaborative learning through the effective use of ICT. (Tan *et al.*, 2011)

Factor #3: Leadership

Leadership is needed to implement a vision, since situations will arise where decisions—*hard* decisions—need to be made. And, while leadership starts at the top, as we will discuss shortly, Mr. Tan empowered his staff—teachers, HODS (heads of departments), technology staff—to be leaders themselves and to make decisions.

Decision #1: Choose a New Pedagogy for NCPS. Nan Chiau took MoE's Masterplan3's silence on what specific pedagogy should be adopted as a license to make its own decision: rather than stick with direct instruction, NCPS adopted seamless learning (SL), a form of inquiry pedagogy (Looi *et al.*, 2009a). In SL, learning is 24/7: whether inside or outside the classroom, students, working individually and collaboratively, are encouraged to ask questions and pursue answers to questions via experimentation, Internet search, and conversation with peers, teachers, and parents.

Decision #2: Choose a Specific Technology. In a still bolder decision, NCPS chose to provide a smartphone (with a data plan, but no voice plan) to each student in the pilot classes. In 2009, 40 students in grade 3 ("P3"—Primary 3, in the Singaporean argot) were issued a Windows Phone 6 (PocketPC) for their use, 24/7. And, in 2011, when the project scaled up, 350 grade 3 students were each issued a Windows Phone 7. While laptops were the computer of choice for the vast majority of schools at that moment in time, the *school's* leadership felt that a mobile device would better support *24/7, all-the-time, everywhere learning,* i.e., seamless learning.

Decision #3: Make a Plan and Stay the Course. While pilot projects in inquiry pedagogy were underway in 2009, the school scale-up plan started in earnest in 2011 with grade 3 science, and it has continued to scale up: now including English, math, and social studies in grades 3, 4, and 5.

A technology project invariably encounters problems in the classroom! It has been our experience in numerous U.S. schools that when teachers come to the principal with tales of woe—*genuine* tales of woe—and the principal says: "ok, the technology is optional," the teachers interpret "optional" to mean "not important," and since there is no time in classrooms for activities that are not "important," the project effectively ends.

But when the teachers came to Principal Tan with their real problems, he said: "let's work together; we can make this work," and the actions he took, in concert with his fellow administrators, his university colleagues, and his corporate partners, to address the challenges, spoke louder than his words. The teachers at Nan Chiau felt that their principal understood the challenges they were facing and was working to the best of his ability to address and to ameliorate those challenges. NCPS stayed the course during that initial set of big bumps and has continued to stay the course.

Factor #4: Resources

School budgets are always tight, and the first response to a new initiative, typically is: "we don't have the money." To secure new funds for the transformation, Principal Tan tapped into a broad range of "connections" in the public sector (e.g., MoE grants supported classroom research) and the private sector (e.g., Qualcomm, through its Wireless Reach Initiative, provided funds for curriculum development and wireless, mobile devices). In Singapore, civic responsibility is taken quite seriously, and Mr. Tan was able to draw on support from a school-based citizens' group and several local companies.

Factors #5, #6: Curriculum, Curriculum!

We count the need for teachers to be provided with curriculum as two factors in order to signify its impor-

tance. In the U.S, the most popular strategy for the integration of technology into classrooms is to ask the classroom teacher to do that integration (Norris, Hossain, Soloway, 2011; Norris & Soloway 2011). Given all that a classroom teacher already has to do, and given how little experience most teachers have with using technology, and given that teachers are not trained in writing curricula, it does not seem like a good strategy to require teachers to create technology-based curricula. But, nonetheless, putting it on the backs of individual classroom teachers is indeed the dominant, and ultimately ineffective, strategy for technology integration in U.S. schools.

The data speak loudly to this strategy's ineffectiveness: when technology is included as a *supplement* to the curriculum, which is typically how teachers integrate technology into their existing curricula, there is essentially no demonstrable impact on student achievement (Greaves *et al.*, 2010; Norris & Soloway, 2011). In contrast, however, the data do suggest that when students use computing technology as an *essential* element fully integrated into their learning environment, then, in fact, there is an appreciable and positive impact on student achievement (Greaves *et al.*, 2010).

NCPS understood the implications of these technology integration studies and made a clear decision to create curricula where mobile devices were, from the start, fully integrated, as *essential* not supplemental tools, into the students' learning activities. With external funding from NIE and internal funding from NCPS, a team of curricula developers—all former teachers—embarked on rewriting the MoE-specified curriculum for science in grade 3 with the goals of (1) using the mobile devices as an essential tool, and (2) aligning those curricula with MoE's MP3 directive:

> Students will be required to use ICT to look for information, synthesise reports, give feedback on each other's work, and collaborate with peers within and outside school. (MoE, 2008)

The task of creating new curricula, where the 1:1, wireless devices were interwoven into the fabric of the daily lessons, was substantial; that task took time and multiple iterations (Looi *et al.*, 2009b).

Fast forward to 2016, and the P3 and P4 science teachers, functioning now, in their own words, as a Professional Community of Practice (Factor #7) have taken over the curriculum development process. The external curriculum developers are no longer needed. But it is important to point out that curriculum development is not an activity that can be done once and forgotten. At NCPS, the P3 and P4 science teachers are engaged in an ongoing process of rethinking, revising, and re-implementing curriculum.

Factor #7: Teacher Change

Research has shown that it is quite challenging to change teachers' beliefs, attitudes, and practices (Blumenfeld *et al.*, 2000; Fullan, 2007). And, in Singapore, that challenge is only exacerbated since the teachers there felt—as the quote at the start of the article illustrates—that they were already doing a *very* good job.

We found that two specific activities did contribute significantly to the teachers' change in attitudes about how children learn, what their role in that process is, and the contribution that the use of 1:1 mobile technology can play in the teaching and learning process.

Ongoing, Intense Professional Development. The type of "professional development" that the P3 and P4 teachers engaged in was not one-day workshops that are the hallmark of professional development in schools the world-over. Rather, for the P3 and P4 science teachers, PD meant getting together, as professionals, at their "TTT" (TimeTable Time—a common planning period), to share experiences, to talk about curriculum, instruction, and technology. They also visited each other's classroom and observed how inquiry was enacted.

By 2014, the science teachers had developed into a Professional Community of Practice and had become self-sustaining. For example, when a new P3 or P4 science teacher is brought into the school, the Community assigns a mentor to that new teacher to help her or him in the transition—since the new teacher invariably had been using direct-instruction at their other school or had been taught direct-instruction in their methods' courses. The P3 and P4 science teachers at NCPS function as a well-oiled team, sharing a common vision and supporting each other.

Seeing Students Learn. After observing a colleague employ inquiry during a lesson, one teacher, who was quite vocal about not feeling the need to change her direct-instruction practices, commented: "Wow, students *can* learn without being told the information."

Those personal, compelling experiences are ultimately what drives teacher change.

Factor #8: Student Change

While teacher change is a well-documented challenge, student change is less documented—but still a challenge! After all, just as the teacher quoted at the start of this case-study was adept at direct-instruction, so too were the Singaporean students. Here is a very telling student quote: When a science teacher tried to use an inquiry approach with a grade 3 HA (High Achieving) class, one student raised his hand, stood when called upon, and said: "Why are you asking us questions? Your job is to provide us

with answers, not questions."

That said, in interviews with the Nan Chiau students, we found a high degree of agreement: using their smartphone made school and learning more "fun" and empowering.

Factor #9: Parent Change

> All in all, the majority of the parents were highly supportive of the use of smartphones for learning.

The above quote (Hong *et al.*, 2015) is based on a survey administered at the end of the 2013 school year to the parents of the students in the grade 3 class. At the start of the project in 2011, however, there was quite a bit of concern voiced by parents about the use of smartphones! After all, when they—the parents—had attended that school, they didn't have smartphones to learn—and they learned just fine!

Parents called Principal Tan and expressed their concerns. Again, leadership was key: Mr. Tan patiently explained to the parents who called why the smartphones were selected as the learning device for the class, and how the smartphones were being used academically.

Teachers and students themselves contributed to "parent change." Homework was expressly designed to foster interaction between a parent and his/her child with the smartphone. And it was easy for the children to show their parents exactly what they were doing in school, e.g., a child could show their parents the animation that the child had created in *Sketchbook* that illustrated the water cycle. Ultimately, the parents became supporters, because they saw their children using the devices for academic learning.

Factor #10: Infrastructure—Technological and Social Changes

Technology Changes for 1:1. In transitioning to 1:1 use of mobile devices, a school needs to re-examine its technological infrastructure, since 1:1 puts new demands on that infrastructure. It has been our experience in the U.S. that schools typically are reactive: something goes wrong and then it is addressed. But Nan Chiau, as we describe below, became more intentional as the school—the leadership and the teachers—came to understand the new types of demands being placed on the school's technological infrastructure as the school moved from a direct-instruction pedagogy to an inquiry-oriented pedagogy.

The School Network: Still the Achilles Heel of 1:1. A telling incident: at the outset, in 2010, getting all 40 students logged into the school's network was a sincere challenge, and initially it took 10–15 minutes of a 40-minute class period. Clearly, that is unacceptable.

But, again, leadership played a key role. Funding was diverted to increase the wireless network's reach and increase the available bandwidth. Nan Chiau now is devoting significant resources to network maintenance, since it is a necessary condition for a successful 1:1 project. That said, NCPS's network, like many in K–12, is still a challenge to support.

MyDesk, MyDesk2, and Supporting Apps. Powering the Nokia 710 devices was a suite of educational apps, *MyDesk* (Looi *et al.*, 2015). The app suite (MLE) available on the PocketPC that supported the curriculum in 2010 were ported to Windows Phone 7 in 2012. In 2014, *MyDesk* was ported by a Singaporean company to Windows 8, and *MyDesk2* is currently being used on the 750+ Windows 8 tablets used by P3 and P4 children.

MyDesk2 stores the students' artifacts on a server, making them easier to access—evaluate and provide feedback on—by the teachers. The server also supports bulletin board-type apps that enable students to engage in (text-based) conversations, 24/7. After all, in inquiry-oriented pedagogy, conversation is critically important—learning is "*in* the conversation."

Social Issues in Pedagogical Change: Classroom Support Changes. In moving to 1:1, hardware and software issues made a daily appearance in the Nan Chiau classrooms. And, as the core competency of teachers is not technology maintenance, leadership stepped up and addressed the issue by putting an IT person in classrooms and by creating a "help desk" to support students directly.

Center for Education Research in Action (CERA): A Physical Place for Collaboration. While schools of education at universities routinely bring in classroom practitioners to work shoulder-to-shoulder with researchers, NCPS's leadership turned that model around. In 2009, at the very beginning of the expansion from the one-classroom pilot to several P3 science classrooms, NCPS designated a room—a very scarce resource in a very crowded school—to house university researchers involved with NCPS teachers. We can't say enough good things about CERA. It created a space where teachers, IT staff, school administrators, and university researchers could come together and talk on a regular, friendly, easy-going basis. Because of the physical proximity of university researchers and classroom practitioners, conversations were constant, trust was developed, friendships emerged, and real sharing and collaboration took place.

DBIR: The R&D Methodology Adopted at NCPS. The style of educational research adopted at NCPS

is called DBIR—Design-Based Implementation Research.

> It is an emerging approach to relating research and practice that is collaborative, iterative, and grounded in systematic inquiry. DBIR builds the capacity of systems to engage in continuous improvement, so that we can accomplish the transformation of teaching and learning we seek. (DBIR, n.d.)

While DBIR-style R&D, by definition, brings individuals with diverse backgrounds together, we believe that it was CERA, the formal organization, and CERA, the physical space, that was the catalyst that enabled DBIR-style R&D to blossom. For example, it was in CERA that individuals from diverse backgrounds and diverse goals were able to "rub shoulders" and in so doing work together collaboratively, i.e., developing and sharing common goals and common understandings. Schools are not just a place for teaching children; schools are a place for educating everyone, and having a CERA made that latter goal explicit and made the goal of educating everyone possible.

The result of these collaborations is that Nan Chiau became more intentional in its step-by-step transition. Dealing with crises is no fun; it drains resources, it causes conflict. Through the daily interactions of researchers, technologists, teachers, staff, and administrators, NCPS became more planful—minimizing surprises and crises. Change, while inherently bumpy, can nonetheless be orderly. CERA provided the physical space where the ups and downs intrinsic to change were smoothed out—civilly and professionally.

Factor #11: It Takes Time to Change!

School change doesn't happen overnight. It takes time for a cohort of teachers to change their practices, for parents to understand that what their children do at school and at home is changing, for administrators to re-think school policies, for IT staff to re-think how they support classrooms with 1:1 devices; and it takes time for students to change their expectations about what they are supposed to be doing in school—and, most importantly, outside of school.

We summarize, as follows, the strategy for change that began in 2009 and continues today at NCPS:

Start Small. *The activities in one classroom provided the basis—students' learned, parents became comfortable, and the teachers felt effective—for the subsequent scale-up.*

Slowly but Steadily Expand. *The adoption of the inquiry-oriented, mobile-technology-fueled transformation systematically spread from a few classrooms to all classrooms in a grade to other subjects and other grades. The school leadership had the patience to grow the program slowly, with a few key teachers stepping up to kick off the change at a new grade level and in a new content area. After the early-adopting teachers ventured forth, other teachers joined in the next year.*

Factor #12: The 800 Pound Gorilla: Testing, Assessment

"Teaching to the test" is a very common theme—and practice—in education, worldwide. Not surprisingly, teachers want their children to do well on the tests, and thus teachers consciously or not, to a large degree or not, skew their classroom instruction to prepare their students for taking "the test." Thus, as long as the dominant, high-stakes assessment is a memorization-style test, it would be unethical and unconscionable for teachers to not skew instruction in order to help children do well on memorization-style questions.

Inquiry-oriented pedagogy does not focus on memorization-style achievement; inquiry-oriented pedagogy quite consciously focuses on helping children develop 21st century skills, e.g., self-directed learning, collaborative learning, problem solving, creativity, etc.

The challenge, then, is this: can students (1) develop "competencies for self-directed learning and collaborative learning through the effective use of ICT..." (Tan *et al.*, 2010), and (2) develop other 21st century skills, e.g., problem solving, explaining, etc., and (3) still continue to excel on the standardized tests? We can answer in the affirmative: students at Nan Chiau still perform very well on content-based exams and they develop a broad range of 21st century skills (Looi *et al.*, 2014; Looi *et al.*, 2015).

Concluding Remarks

Central to the Nan Chiau story is this: Nan Chiau's transformation was a school-level transformation, not a teacher-centric transformation. While the media can highlight the miracles that this teacher or that teacher has created in this classroom or that classroom, when those miracle-working teachers leave their classrooms, the miracles stop. Teacher-centric change does not scale; schools don't change because of one teacher's changes. In contrast, school-level transformation is a non-glamorous, time-consuming, team sport where, at the outset, there is great potential for failure.

Technology was the catalyst for school-level change; wireless, mobile devices, 1:1 were the proximal cause around which everyone—especially the teachers and the students—rallied. For the students, the wireless device enabled them to do inquiry, to use the Internet to ask and explore questions, 24/7. For the teachers, the devices were the opportunity to create new types of learning activities—authentic, engaging, active activities. While inquiry pedagogy could be enacted without wireless, mobile devices, those devices make

the enactment significantly easier, more effective—and definitely more fun!

While there are cultural differences between Singapore and the U.S. and elsewhere, and while solutions to the 12 factors may differ due to those cultural differences, the 12 factors for school change discussed here are themselves culturally neutral. Thus, the lessons learned from school change in Singapore are absolutely relevant to what is going on outside Singapore.

One factor, in particular, is exceedingly relevant to the *Sturm Und Drang* now taking place in American education: time—it takes time to change. Indeed, the charter school movement in the U.S. is learning about that factor: "charter performance is generally improving *over time*, both compared to traditional schools, as well as to the past performance of charters themselves" (Pondiscio, 2015). Thus, while there is considerable talk (e.g., see Norris & Soloway, 2015) that K–12 needs to be "Uber-ized"—needs to start afresh, building up K–12 schools around a software core (Norris & Soloway, 2016)—what we learned in Singapore, and what the charter movement in the U.S. is learning similarly, is this: *there is no quick fix to creating 21st century schools.* □

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