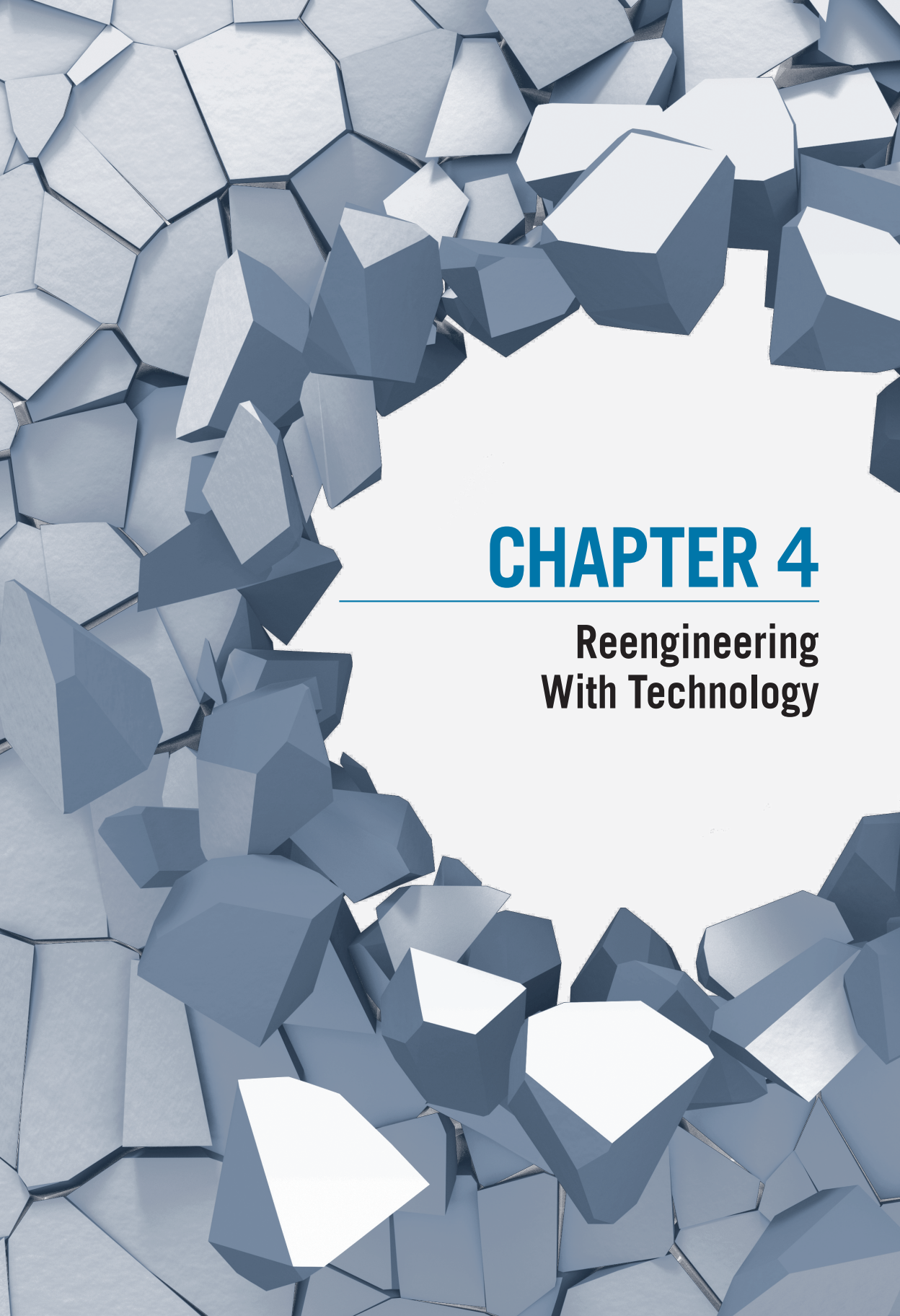

CHAPTER 4

Reengineering With Technology

Technology can be a powerful lever for rethinking schools and systems. But it's the rethinking that should occupy the spotlight. As education leadership authority Michael Fullan has noted, "There is no evidence that technology is a particularly good entry point for whole system reform."[1] Technology can provide tools to help deliver knowledge, support students, extend and deepen instruction, and refashion cost structures. Unfortunately, too many educators, industry figures, and technology enthusiasts seem to imagine that technology itself will be a difference-maker.

Jared Covili, a professional development trainer in Utah who helps schools integrate technology, sees many schools buy technology without a strategy for use. The result: Nothing really changes. He says, "A school might run out and buy 200 iPads before they really have a strategy. If you don't have a vision for what you want to do in your own building, iPads really kind of become just a device to check e-mail and maybe play some games on. Instead of showing your PowerPoint through a projector off of your computer, now you're using your iPad to do it. . . . [I]t hasn't really changed the instruction. It's just changed the way you're presenting it." As *Disrupting Class* coauthor Michael Horn notes, "The education system's inclination when it sees a potentially disruptive technology is to cram it into its existing model to sustain what it is already doing."[2]

Enthusiasm for wildly new "disruptive innovation" has sometimes blinded us to the fact that, 90% of the time, technology's biggest impact is optimizing or enhancing familiar tasks and routines. This frees up time, talent, and dollars for better uses, fueling improvement. If teachers with one-to-one devices can, each day, spend 10 minutes fewer entering data, 10 minutes fewer passing out and collecting texts and papers, and five minutes fewer pulling up student assessment results when working to differentiate instruction, they can save more than two hours a week—or more than 70 hours a year! That's time they can devote to instruction, mentoring, or lesson design. That's a giant benefit, and likely to be more significant than from learning solutions that are touted as more revolutionary.

Too often, rather than using new tools to free up time or make better use of talent or resources, new solutions are ladled over what's already in place. Steve Hockett, principal of Colvin Run Elementary in Fairfax County, Virginia, and former principal in

residence at the U.S. Department of Education, says, "I've gone into schools where they say, 'We have smart, interactive whiteboards in every classroom.' And then I'll go visit classrooms and they're basically using the whiteboard as an overhead projector where the print can't even be seen in the back of the room. So it's not interactive and it's not even a very good overhead projector, yet it costs $2,500. . . . If I were to say, 'What am I seeing that's not successful?' it's people who are basically spending lots of money to own a Ferrari to drive a block to the store and back every day."

Hockett faced a familiar problem. He explains, "Our schools have immersion programs that kids can opt to go to where they learn math, social studies, and science in a second language. For instance, in second grade, a school might get half of their instruction in a subject in Spanish. Our school tried to participate in the program twice, but we didn't get it, and then the funding all went out because of the budget. We needed an alternative to a fully funded program with new staff. So I was talking to the PTO [parent-teacher organization] president about it and I said, 'I wonder why we just don't do Rosetta Stone or something and teach our kids Spanish.' So we looked into it and we did it, starting with first and second grade."

The challenge: Hockett quickly realized that simply adopting Rosetta Stone as a stand-alone wasn't going to work. He explains, "At that point, Rosetta Stone was just for the student. So it was totally asynchronous. Our first- and second-graders were bored to tears. So the intent was good but the implementation and practice weren't that successful. It wasn't as engaging for kids. . . . We put our heads together, and we decided that we love the idea of kids getting Spanish instruction, but we had to change how we're delivering it. So, with additional PTO support, we decided to have first- and second-graders get Spanish twice a week with a Spanish teacher. For Grades 3 through 6, 50% of their time was spent with Rosetta Stone and 50% with a teacher." Colvin Run used new technologies to enrich learning in ways that fit its constraints. Hockett identified a strategy for using those tools, determined what was and wasn't working, and then made sensible modifications. This is how a learning engineer operates.

How can we be sure to get this right? For a clue, think back to our discussion of your familiar, friendly book in Chapter 1, and

how it successfully yielded transformational change in teaching and learning. Indeed, there are other familiar learning "technologies" that have had big impacts—so familiar, we don't think of them as technologies at all.

THE SOCRATIC METHOD

Consider a "learning technology" that's even older than the book: the "Socratic method." The Socratic method is the most basic approach imaginable to assessing, diagnosing, and intervening with students. Compared to the lecture, with its emphasis on conveying information, the Socratic method is a basic "technology" for helping to cultivate mastery through practice and feedback. Why was Socrates so skeptical of the written word? Because it threatened to undermine the genius of the instructional approach that now bears his name.

In the Socratic method, the teacher challenges students with questions that stimulate the application of new information, provide feedback, build critical thinking, upend comfortable assumptions, and illuminate ideas. It's a dialectical method, in which the teacher often plays devil's advocate, pitting herself against whatever response the student provides. The technique is often used to lead the student to contradict himself in some way, in order to steer him toward a new understanding or insight.

Where books are fixed, the Socratic method is dynamic. Where books must be pitched at some median reader, the Socratic method permits constant adjustment to the interests, limitations, and needs of a given student. In the hands of a skilled instructor, the Socratic method is perhaps the most powerful model we have for promoting understanding, engagement, and mastery through individualized practice and feedback.

So if we already have such a powerful tool to encourage learning, why can't we use it to improve learning at scale?

The problem is twofold. First, the Socratic method is really hard to do well. Lots of people might try to do it or might think they're doing it, only to execute it poorly. Second, the Socratic method is really expensive. Employing this method of teaching requires a skilled educator working with a class of perhaps

15 students. Thus, it's really difficult to effectively deliver the Socratic method at scale.

This is where a learning engineer asks whether technology might help extend the benefits of the Socratic method, just as the book made available at scale, at least in part, the benefits of the best teachers. Maybe we can't clone the best Socratic teachers, but perhaps we can duplicate some of the benefits they provide and deliver those to a broad population.

This is exactly the way to think about those intelligent tutoring systems from Chapter 3. The question is not whether such systems can match the best human tutors but whether they can provide millions of students a tutoring experience that's affordable, accessible, and "good enough" to support learning.

THE ENCYCLOPEDIA

A familiar piece of learning technology is that increasingly outdated standby, the encyclopedia. The encyclopedia uses book technology to make knowledge of a wide array of phenomena and facts universally available. In truth, once upon a time, the encyclopedia was massively successful at doing this. Encyclopedias first reached a mass audience in the 1920s, when multivolume sets like *World Book, Encyclopaedia Britannica,* and *Collier's* were sold door to door. These volumes made a wealth of information suddenly available in an accessible fashion. They were also vast, unwieldy, and incredibly expensive, selling, by the 1980s, for between $500 and $2,000 a set.[3] Sales of *Britannica* peaked in 1990, when it grossed $650 million.[4]

Encyclopedias provided a unique, valuable resource. Indeed, it was once considered a parental failing for a family with a sufficient income to not invest in an encyclopedia. But the cost, unwieldiness, and inability to update an existing set were all big limitations. New information technology led designers to ask how they might provide this vast body of information without asking readers to fumble through reams of paper and dizzying amounts of text, in a more user-friendly and affordable fashion.

Born in the mid-1980s as a brainchild of Bill Gates, Encarta was Microsoft's response to that question. Microsoft released the $99 CD-ROM software in 1993 and sold more than a million copies

the following year.[5] Eventually available online and on DVD, the complete English version of Encarta contained 62,000 authored articles at its peak—or 50% more entries than the most comprehensive version of the *Encyclopaedia Britannica*.[6]

But Encarta had its own limitations. It was self-contained, couldn't be updated in real time, and was expensive to produce, and accessing it required sitting at a computer. As the web and then smartphones became more widely available, Encarta rapidly grew obsolete. It finally faded away in 2009, giving way to the crowd-sourced, more collaborative (and free) online encyclopedia Wikipedia. Launched in 2001, Wikipedia contains over 4 million English articles—or about 100 times as many entries as the most comprehensive version of the *Encyclopaedia Britannica*. When it discontinued Encarta, Microsoft explained, "The category of traditional encyclopedias and reference material has changed. . . . People today seek and consume information in considerably different ways than in years past."[7] That's exactly right. The encyclopedia was a better way to share a vast quantity of accumulated human knowledge than simple memorization. And free online collections that are continuously curated with a hundred times as much information are a better way yet.

NEW TOOLS *CAN* CREATE NEW CAPABILITIES

If we view technology as a tool, a couple of things become clear. First, using technology in the classroom is nothing new. We've always used tools to support learning, whether those were the Socratic method, book, pencil, film projector, or calculator. Like the tools that came before, today's learning technologies are often just cheaper, faster, more universal ways to do things we've always done. As Idaho state superintendent Tom Luna has said, "Technology is not replacing teachers . . . technology is replacing chalk."[8] There are cases, however, where they can also offer the opportunity to do things that were previously impractical.

For example, for all the recent enthusiasm over virtual schooling, distance learning isn't a new idea. In the United States, distance learning can be traced back at least to the correspondence courses of the 1800s. In that sense, online instruction is just a faster, better, more accessible way to deliver that instruction.

Contemporary technology makes possible remote interaction between teacher and student that's dynamic, interactive, and customizable in a way that was once inconceivable.

Consider how the emergence of new capabilities plays out in the case of two familiar challenges: teacher evaluation and extended learning time.

Boosting the Value of Teacher Observation

With all of the attention that states and districts are according to teacher evaluation, a persistent challenge is finding ways to create more time for helpful and rigorous observation. The problem? Just think about the mechanics of teacher observation. An observer may sit in the back of a classroom for 30 or 40 minutes, recording what she observes by hand. After class (if the teacher has a break) or when there's an opportunity, the observer and teacher will discuss the class, with the observer discussing from her notes and the teacher trying to recall what happened. The whole exercise may require an hour or more of observer time, as well as the need for the observer to travel for the class and then hang around until she and the teacher can connect.

Consider how a 21st century professional baseball coach might handle the same situation. If he's watching a player take swings in the batting cage, the coach might have the player stop each time there's something worth noting—addressing it in real time. More likely, though, the coach won't stand there and watch each player take each swing; after all, that's time-consuming and logistically difficult. And, practically speaking, it's impossible for a coach to give that player real-time feedback when he's in the batter's box during games. So, what does the coach do? He tapes all of a player's swings—in games or practices—and then reviews those with the player when it's most useful.

Los Angeles Angels first baseman Albert Pujols, a perennial all-star, has casually noted that he travels everywhere with a laptop that includes video of every single swing he's taken in the past decade. That way, the coach needn't try to describe what he saw; the coach and the player are watching the same thing simultaneously, and it can be slowed down and repeated, and compared to prior efforts to fix a flaw. It makes for a more concrete and useful session—and something the player and the coach can revisit, as needed.

Bringing that same intuition to teacher evaluation makes two things possible. The first is using technology to do teacher observation and evaluation more effectively and efficiently. The second is leveraging technology to think in wholly new ways about these tasks.

Start with the first, more modest, goal. A school with 40 teachers, each needing to be observed at least five times a year, requires a minimum of 200 observations across the school year. If each observation requires an observer sitting in the back of the classroom, with that observer arranging to meet with the teacher as soon as is feasible after class, that probably adds up to 200 hours or more of observation, feedback, and reporting time. During the bulk of that time, the observer isn't working *with* the teacher and providing feedback, but is instead taking notes, waiting to meet with the teacher, or filling out forms. Even during the actual feedback session, the teacher can't see what was or wasn't happening in the classroom—he can only listen to the observer and try to recall what was happening inside the class and inside his head at the time.

Technology offers the chance to reengineer this process. Imagine the school possesses even a couple of digital classroom cameras (at the high end, similar to panoramic cameras supplied by companies like Teachscape, but they don't have to be this fancy). This changes the observer process: The teacher can record his own class, independent of an observer's schedule or travel. They can schedule a debrief at a mutually convenient time, confident that they won't forget what happened in the class (at least, the events outside the teacher's head—to get the teacher's perspective on what he was thinking, they still wouldn't want to wait too long). The observer can watch the tape ahead of time, perhaps even make notes online, rubric in hand, using a video discussion tool like Vialogue. The observer saves time, logistical challenges are reduced, and the feedback session becomes much more dynamic and specific. If both teacher and observer make notes during their discussion, there's a very specific artifact that both can review later.

If a school stretches a little more, the technology makes it possible to rethink the entire process of structured observation. Cameras and video make it possible for a teacher who thinks, "Hey, I'd like some coaching or feedback on this lesson—it's

always a tough one," to get it, even when no designated observer is available. That teacher can tape the lesson and then arrange to watch it on a laptop at a bar later that afternoon with a colleague or two, brainstorming what to do next time, or with the assistant principal before school the following day—or even to share it virtually with a mentor somewhere else in the world while holding a Skyped conversation about what they're seeing.

Suddenly, new career opportunities open up for teacher coaches. Why not a sideline as the city's best fourth-grade "fractions misconceptions" lesson coach? Or what about building a portfolio of coaching topics, put out a virtual shingle that says "The coach is in!" and charge $40 an hour for mentoring? Why not become the best fraction misconceptions lesson coach in the western United States, for students aged about 10–14, then link up with other coaches with complementary skills? And then tape your own coaching sessions with teachers so that you can find a mentor who can coach *you* on how you're working with your colleagues.

In other words, technology makes it newly possible to have the kind of engaged, sustained coaching that's so difficult to provide when it depends on individuals traveling to view classrooms, when a debrief has to happen almost immediately to be useful, when opportunities for feedback are constrained by scheduling, and when communication and coaching delivery are restricted by physical presence and time. And, by the way, it creates terrific new opportunities for professional educators to grow and share their skills.

Making Homework More Useful

Students are in class for about six hours a day, 180 days a year. For many students, that's clearly not enough time to learn all that we might wish. So, we ask students to read textbooks at home and to solve problems, write papers, and tackle projects as homework. The problem: Students often don't do the reading and assignments, might need more explanation, or may do the work halfheartedly and in isolation.

Worse, most textbooks are mediocre from a learning science standpoint—they're too distracting, pay insufficient heed to how words and illustrations work together, and use language that's frequently too difficult for tough topics. Pitched at a mythical median

student, textbooks also inevitably are not suited to the optimal level for the majority of students. What's more, even if a student does the assignment, the potential benefit is lost if the teacher simply lectures on the same material the next day in class and doesn't engage students in practice and feedback concerning what they read.

One promising response to this dilemma is the emergence of the "flipped classroom" model popularized by schools and systems taking advantage of video lessons from Khan Academy. (For those unfamiliar with the term "flipped classroom," it typically means that schools have "flipped" the instructional model by asking students to view taped lectures as homework, so that they can engage in collaborative, active learning during class, including the problem solving that used to be the homework.)

Now, in theory, books were also an attempt to "flip" the classroom. As we noted in Chapter 1, the book made it possible to learn at home things that students could previously learn only in school. However, in practice the book has often disappointed. We can flip the classroom, but let's think carefully about what's changed. The video lessons may be good, or mediocre, from a learning science standpoint. Students may not watch the assignment. Even if they do watch, the teacher will defeat the purpose if he just reviews the content the next day in class.

It may be that online lessons can be more engaging and appealing for 21st century students, but it seems many of the familiar challenges remain, including one of the biggest: What does a teacher do if five students out of 30 don't do the assignment the night before? Whether the teacher is using books or videos, there's a high chance that those five students are the ones who are faring most poorly, and teachers feel obliged to spend a lot of class time focused on reteaching or reviewing the lesson with an eye to those students, potentially limiting the practice-and-feedback benefit from the flipped structure.

Breaking that dynamic is not a question of having the technology but of how teachers use it. Successful designs start with identifying the problem. One problem may be that the assigned work, whether video- or text-based, isn't a good fit for a student's current level of mastery (e.g., what that student has in long-term memory). One-to-one tutoring could solve this, of course, but that can be tough to manage. Now the proper learning engineering question becomes, "Can technology help solve this in a better way?"

Imagine that the learning system used information about baseline student mastery to decide what video and practice to provide a student *this* evening. The suggestions could be based on the experiences of hundreds or thousands of other students who are "like" this student in important ways. The system could then provide a learning experience that draws on what this student has already mastered, and that—because it's challenging but not too challenging—may be more likely to motivate the student.

Let's take this a little further: Imagine that after the homework is completed, the system provides information and guidance to the teacher about the next day's instruction. It suggests which students should engage in which activities, based on their interests and level of mastery. This makes it exceptionally easy for the teacher to differentiate instruction.

Does this sound too far-fetched? Too impractical? Guess again. Aside from the use of video, this describes the SmartTrack system, mentioned in Chapter 3 and used by Kaplan in many of its SAT test-preparation environments. Before an in-class session, students work with an adaptive learning system that allows them to work on practice problems that match their level of mastery. The system then makes recommendations as to which students should be assigned to which subgroups for specific additional activities in the class.

So this can be done. Should *you* do it? Can you do it well? Those are the questions that preoccupy a learning engineer.

ENGINEERS ASK A LOT OF QUESTIONS

Engineers start by asking a lot of questions. Why? If you build stuff without asking a lot of questions about who'll be using it, how they'll be using it, and why they'll be using it, you make it a lot less likely that you'll engineer anything very useful. Asking questions like this is how engineers make sure they know what problem they're solving.

Patrick Larkin, assistant superintendent in Burlington, Massachusetts, who led a one-to-one iPad adoption when he was principal of Burlington High School, offers an example of how to do this right: "It's not about the technology; we're not training teachers to say 'How do I use the iPad in my classroom?' I think the questions we got better at asking were, 'What are my goals

that I'm trying to accomplish with my students? What are the learning outcomes that I'm looking for?' That's always the first question whether you're in an environment that has technology or not. And with the support of some of our integration specialists, they're able to come in and help show ways teachers can get to those benchmarks faster or get more assessment data."

Dennis Villano is one of those specialists; he oversees technology integration for Burlington Public Schools. He sees his job as one that focuses on the learning process first and products second: "It's something I really feel very strongly about. I think that schools need to flip their way of thinking, and they've got to stop thinking about applications first, and then devices, and then infrastructure last—they need to think about why they're doing it. They need to let the educators drive technology and not necessarily let the IT departments be the driving factor. We've kind of flipped the way that we've traditionally thought about educational technology and we've gone for why it's important, not so much what's the coolest new toy that's out there and available to buy."

This kind of focus is essential. It points to the right questions. What's not working with how the problem is currently being addressed? What needs to be done differently? Do students need more powerful instruction, time-on-task, remediation, or high-quality assessment and feedback? Do faculties need more support, better data, or coaching? In any of these cases, how might technological tools help?

The tendency of technology enthusiasts to overpromise and of skeptics to insist that new technology will undermine schooling suffer from the same confusion. What matters is not the technology, but what it can do to promote learning. The place to start when it comes to technology is *not by focusing on the technology but on the learning challenge.*

Readers may note the similarities to the concept of "design thinking" that we've mentioned before. In K–12 circles, "design thinking" is sometimes understood to mean having students solve complex design problems.[9] We have something different in mind. Tim Brown, CEO and president of IDEO, an international design firm, for instance, notes that we often believe "Great ideas pop fully formed out of brilliant minds, in feats of imagination well beyond the abilities of mere mortals." The truth, he reminds us, is that design is a process of hard work, creative discovery, and "iterative cycles of prototyping, testing, and refinement."[10]

Say you're fixing a house. You can note that the house is in rough shape and needs to be repaired, but that doesn't offer much guidance. It's slightly better to say the problem is that the house is leaky. But it's still not a very precise statement of the problem. Why is it leaky? Where's the water leaking in from? Is it because the roof is shot? Because there are missing windows? Because there are cracks in the foundation? Any of these problems can be addressed with the proper tools and materials, but you need to know what the actual problem is before you can fix it.

The same goes for schooling. Observing that a school is "failing" doesn't do much to help identify the problems that need solving. What is it "failing" to do? Are teachers unable to provide strong content instruction? Is there a lack of parental engagement? Do students need extra support and mentoring in particular skills or subjects? A more precise rendering of challenges and solutions can illuminate what needs to change and where technology can help. For instance, if you determine that certain students really need intensive, one-on-one tutoring, why aren't they getting it? Is it hard to find properly skilled adults locally or for your teachers to find free time to do it?

If so, you may consider exploring online tutoring. There are online tutoring providers who can provide 24/7 one-on-one tutoring in dozens of subjects. For many, the cost will work out to something less than $30 an hour.[11] In fact, community college systems pre-buy this kind of tutoring in bulk, purchasing thousands of hours at a time. If you give up one FTE and that slot costs you about $72,000 in salary and benefits (the national average), you can pick up more than 2,400 hours of one-on-one tutoring. That's an hour a week for more than 60 kids. Whether that trade-off is a good one is a matter of context, judgment, and values—a learning engineering decision.

WHAT PROBLEM IS THE IPAD SOLVING?

Schools and districts too rarely use new technologies as an opportunity to rethink their work. Instead, teachers and school leaders tend to talk excitedly about "innovation" or a single nifty lesson. Doug Levin, executive director of the State Educational Technology Directors Association (SETDA), worries about this tendency: "We do hear stories about school districts or schools that say, 'Hey, we just got a

grant or we just found out we got extra money, and we're just going to go out and buy a bunch of stuff . . . and the iPad because we really like it.' And then the next question is 'What are we going to do with it?' It's a terrifying story, and I hear it unfortunately a little bit too often."[12] The result is that technologies just get overlaid on existing routines.

A learning engineer regards tablets, digital textbooks, or online learning not just as opportunities to improve instruction but also as a chance to manufacture time, extend the reach of talent, or generate savings. This starts with figuring out where you're trying to go, what problem you're trying to solve, and what barriers need to be removed in order to get there.

If we're thinking about the iPad, here are some possibilities worth considering:

- How does the iPad permit you to reconfigure professional development? Does it allow just-in-time or asynchronous training, or make it possible to customize delivery and more readily use online providers instead of drive-by, more expensive professional development?
- How much time can teachers save by taking attendance via a scanning application? In a middle school or high school, if a teacher saves three minutes a class, five times a day, they can save more than 40 instructional hours a year.
- How much can online assessment on devices speed up test taking and feedback cycles for teachers, and how should this change work routines and the dynamics of a professional learning community?
- How much time can teachers and administrators save on data entry, if the school or system is careful to ensure that it's adopting data processes that run cleanly off the tablets? If teachers are saving 20 minutes a day of data entry and record-keeping, that can add up to more than 50 hours a year of energy they can redirect into preparation or mentoring.
- Can teachers set aside pre-prepared instruction for those days when they'll be absent, or can teachers provide full classes and assignments for days when students may be sick? Given that the typical teacher misses five to 10 days a year and the typical student nearly as much, this has the potential to increase the average instructional year by 50 to 100 hours.

Such questions can help point out where tablet adoption can offer new opportunities to boost learning time, save funds, or get more value from scarce talent.

WHAT HAPPENS WHEN YOU DON'T THINK LIKE A LEARNING ENGINEER

When we confront new technologies without a learning engineering mind-set, we too often focus on the devices or the technology rather than the learning. Case in point: We were struck by the highly regarded Ohio principal (mentioned in Chapter 1), who proudly explained to us, "We encourage our students to use mobile devices. . . . For example, a couple of years ago one of our teachers allowed a student to type an entire research paper on his iPhone. It was very hard, but it was eye-opening for everybody. To us, it's like, 'How in the world did he type an entire research paper on an iPhone?' but, to him, that's the device he was comfortable with. He owned it, he used it every day, so, why not?"

Why not? Well, the iPhone is a terrific tool for a lot of things—but it's a lousy tool for writing a term paper. Sure, the student liked using it and was probably adept at doing so, but the working memory distractions of navigating and reviewing his argument a thimbleful at a time means the student couldn't readily review the organization of the writing or consider the whole of his essay. The result, in terms of helping students learn to write well, is a subpar learning experience. It's as if someone bought a private jet for a school in order to give flying lessons, and the principal decided to use it to it to plow the parking lot in winter. The school would be using sophisticated technology to do a simple task that an old pickup truck could do *better.* If the principal bragged that he was excited about his maintenance guys doing jet-based snow plowing, we hope that he'd be ridiculed, not celebrated.

When a student is doing a routine task and learning no more (or less) than before and the exercise seems noteworthy only because of the technology used, we've lost sight of what matters. We're putting the spotlight on the wrong part of the stage. We'd have been impressed if the principal had felt inclined to remark upon the *learning* or the *student's work* or something else that

matters that was improved in the delivery process. He stoked our concern here when he passed right by those in his fascination with the technology itself.

Lenny Schad, former chief information officer at Katy Independent School District in Texas (now in a similar role in Houston), articulates this clearly. In discussing Katy's bring-your-own-device program, he notes that a tendency to focus on technology can lead educators and parents to talk about mobile learning and "bring your own device" initiatives as if the presence of devices inevitably improves learning. He says, "Based on what we've seen over the past three years, that couldn't be further from the truth. Mobile learning is all about changing instruction, because if the instruction inside the class doesn't change, then allowing the kids to bring their own device will do nothing. If the teacher still teaches like they did with paper and pencil, then the devices add no value. So bring your own device is not about the device; it's about an enabling tool that allows a philosophical change in instruction."

We've visited schools acclaimed for their one-to-one computing, personal computers, and iPads, only to see students scouring the web for material to cut-and-paste into a report, or desultorily dressing up rote presentations with colorful clip art and creative sound effects. This can be as true at "technology-infused" high schools as at your local elementary. Jerry Crisci, director of technology for Scarsdale Public Schools, relates, "The classic example that you see in a lot of schools is asking kids to do PowerPoint presentations where the presentation models a traditional report. If I'm studying the civil war in middle school, the assignment would be to do a PowerPoint presentation on the Civil War. They *could* flip the assignment around. For instance, you might instead ask the kids to do a presentation where you compare and contrast the attitudes of people who supported the Confederate or the Union side . . . That would entail having kids look for patterns and construct new knowledge, and not just giving a presentation on something. Which, frankly, often leads to kids just copying and pasting from a reference source."

We routinely see technology used in ways that amount to students using Google-cum-Wikipedia as a latter-day *World Book* encyclopedia. Video shorts are nice, but it's mostly us "digital tourists" who think it reflects impressive learning. Twenty years ago, even rudimentary video editing was technically challenging and required

real skill. Today, it can be as simple as clicking a few buttons on iMovie. It's not a question of deep knowledge so much as a familiar set of routines. Unfortunately, it's easy for adults to get so distracted by the visuals, stylings, and sounds that we fail to note that the content is a vapid assemblage of Wikipedia-supplied factoids. Indeed, students may be distracted from taking time to synthesize and apply knowledge and procedures because, for example, they were picking the ultimate background music.

Two cautions are worth noting here. The first is that much of what passes for tech-infused learning today frequently does not mean that a student has mastered the outcomes needed for long-term success. The second is that some of what passes for "21st century skills" can involve the mastery of "skills" that actually aren't all that difficult and may even distract from the real mastery needed for the long haul.

Terms like "digital natives" can be unhelpful when they suggest that any skepticism is evidence that an adult "doesn't get" 21st century learning. Back in the 1980s, parents were befuddled by high schoolers who could manage the tricky feat of talking on the phone for hours while playing Atari. Yet, happily, few adults mistook these pursuits for learning or thought the kids in question had mastered new, valuable skills. A student using an iPad to consult Wikipedia to find a description of the Harlem Renaissance is, other things equal, learning no more than did a student 25 years ago who used an encyclopedia to find the same information—except that the ability to digitally cut and paste can make it even easier for today's students to avoid processing knowledge into long-term memory.

Joel Rose, founder of New York City's School of One and the national hybrid school designer New Classrooms, explains, "Many of our technological capabilities . . . are either inaccessible or clumsily grafted on. Three computers added to the back of a classroom may look like a positive step toward bringing that classroom into the advanced technological age. However, smoothly integrating three computers into a daily lesson is not always easy when a teacher has to consider the needs of 28 students all learning at the same time."[13] The National Center for Education Statistics for instance, has reported that, while 99% of teachers have access to computers in the classroom, only 40% of them claim to use the computers often; 10% say they never use them.[14]

MOORESVILLE GRADED SCHOOL DISTRICT: FISH DON'T TALK ABOUT WATER

When fish gather for an evening of leisure around the reef, we imagine they don't spend a lot of time talking about how remarkable it is that they live in the water. We suppose they might chat about water quality, scenic vistas, scary predators, and delightful meals, but we doubt they spend much time saying, "Hey, how crazy is it that we live underwater?" We feel confident saying this because we know hardly anybody who spends a lot of time saying, "How crazy is it that we walk around breathing air?"

The relevance of this little aside? When we are talking to school and system leaders who really know what they're doing with technology, we're always struck by how little they talk about technology. Like the fish, they take the medium they swim in for granted; their focus is on the students and the learning.

Starting in 2007, Mooresville, North Carolina, moved to issue laptops to all fourth- to 12th-graders and licensed staff, provided 24-hour access, and adopted smartboards in all K–3 classrooms. At the same time, Mooresville's website goes out of its way to caution, "Technology alone is not a panacea, thus the real focus is how we engage our students with this instructional tool to get results and add value to their academic performance."[15] The *New York Times* has reported that the system's teachers and administrators say they value technology not for the "newest content" but for helping educators wrestle with student "curiosity, boredom, embarrassment, angst" and "deliver what only people can."[16]

Students in a Mooresville classroom

Superintendent Mark Edwards says, "This is not about the technology. It's not about the box. It's about changing the culture of instruction."[17] This has all paid off, big time. In 2013, *Scholastic Administrator* named Mooresville the best school system in the country, and the American Association of School Administrators named Edwards the nation's superintendent of the year.

As Edwards tells it, the district took pains to put learning solutions first, and then used technology to implement them in an affordable way. He says, "We melted the walls. We redesigned the classrooms. We don't have straight rows. We don't buy desks anymore. We only buy tables, and we aligned them so that the teacher is really moving." Classrooms don't have a traditional "front" and "back" because teachers are circulating or teaching from the middle of the classroom. This sounds a lot like what should happen when we apply learning science to classroom design, with an eye to engaging all students in deliberate practice and providing timely feedback. Indeed, it's what dynamic instructors have been doing and recommending for decades, with technology helping to make such instruction more feasible in more classrooms. Remember, technology doesn't change the rules for learning; it just complements it.

But Edwards makes it clear that the technology is complementary to the district's focus on instruction and pedagogy. Edwards says, "We focused on achievement from day one, so we've had formative data meetings throughout the year, and we look at classes, schools, individual students. On a regular basis our teachers are talking about their work. They've had a 1% raise in four years, and yet morale is real high because they were successful."

In classes, teachers are expected to focus on practice and feedback, rather than lecturing. As Edwards relates, "One visitor said, 'You know, I just spent three hours in the school and didn't see one teacher teaching to a class.' I told them, 'You might stay here a week and not see that.' The teacher will give an overview of what we're working on and then there will be a project group over there working on one thing and individual students working." Edwards has said he expects "a teacher . . . will deftly move among tables of students, listening and observing intently, then engaging as needed with groups or individual students. It's a physical approach to teaching, but the benefits of proximity are truly significant."[18]

When it comes to assessment, Mooresville focuses on rapid feedback, making it an integral part of the instructional process. Edwards says, "An observer just yesterday was watching a teacher give a formative assessment, when somebody asked the teacher, 'When will you get this back?' The teacher said, 'Well, if you give me 10 seconds, I'll have it back.' It's this immediacy of information and the level of precision that is stunning.

Students in a Mooresville classroom

At any time, teachers can articulate to any parent or student, with exacting detail, how the student is doing. That's absolutely impossible without the digital resources."

When vendors come calling, Mooresville insists on piloting even the most promising tools before adopting anything. Edwards explains that if a cool-seeming tool comes up short, either on performance or on ease of use, Mooresville passes. He says, "If something doesn't cut it in a couple of years, it's time to make room for something else."

Mooresville's track record since it began its digital conversion in late 2007 suggests that this kind of approach can pay big dividends. Between 2007 and 2012, proficiency on core-subject state exams in reading, math, and science rose from 68% to 89%, the graduation rate increased by 14 points to 91%, and the share of graduates attending a two- or four-year college rose from 75% to 88%.[19] Meanwhile, in 2011–12, Mooresville ranked third in the state for graduation rates and second in student test scores, while ranking only 100 out of 115 districts in per pupil spending, with annual outlays of $7,400 per student.[20]

But "success" goes beyond improvement in student performance. One Mooresville teacher explained, "I think 'expectation' is the right word. . . . The expectation is, 'Here is your laptop, and you will learn how to use it.'"[21] Mooresville High School Principal Todd Wirt has said of Edwards, "He just doesn't allow anybody around him to make excuses or build obstacles."[22] Leaders in Mooresville say would-be imitators need "leaders who see budget and procedural restrictions as obstacles to be conquered, not feared."[23]

Edwards says that the culture of teaching has been transformed: "Two years ago we asked the teachers to come to the summer institute for the grand fee of $50. This is a three-day training session, so it was really nothing more than a token payment. This past year we had 94% attendance. So the teachers have bought into it. Another key thing is that we really worked at and were

thoughtful about building the cultural aspects of this. We looked at the culture within the school community, the student community, and the teacher community. Now, if someone's not onboard, they really stick out. The staff feels like, 'Wow, what's wrong with that person?'"

In his popular book *Every Child, Every Day,* Edwards sums up Mooresville's goal for its digital conversion: "We are not trying to add on to old ways of teaching and learning. Rather, we are trying to 'rethink school' from the ground up, enabled by today's technologies and guided by the demands of the 21st-century workplace."[24]

TECHNOLOGY CAN BE A POWERFUL TOOL

Recall our two historical examples of powerful early learning "technologies," the book and the Socratic method. The book helps learning by providing relief to working memory—students don't have to remember everything a lecturer tells them; they have a source to review and return to. Yet the book is a fixed medium—it says the same thing in the same way to every learner who approaches it. The Socratic method helps learning by providing high-quality practice and feedback, personalized to the learner's own stage of understanding. Yet it is an ephemeral experience—you have to remember what happened to you during the questioning.

Today's technology offers the prospect of getting the best of both of these approaches into new learning environments. Adaptive learning environments can be repeatedly accessed to retrace ground that's been covered before, while providing the challenge that all learners need, when they need it. This has the potential to provide the best of both worlds.

This is why it's exciting to think about bringing technology the right way into students' and teachers' lives, tapping into learning science while taking advantage of what technology can do.

Joel Rose, founder of national hybrid school designer New Classrooms mentioned a few pages back, observes that technology can "allow us to re-imagine new combinations of educator expertise, time, instructional materials, research, physical space, parental support, and (yes) technology in ways that achieve

optimal outcomes for students. . . . [Through] a combination of teacher-led instruction, student collaborative activities, software, virtual instructors, and a complex scheduling algorithm [we can now] enable each student to move through an individualized learning progression at his or her own pace."[25]

Technology can be a terrific resource—as in Mooresville—if we start with the learning problems, find better solutions to them, and use technology to make those solutions more affordable, reliable, available, customizable, and data-rich. This is the essence of good learning engineering—not to jump at every cool idea that floats across the ed-tech ether, but rather to be aware of how your current learning environments are missing something better for learning, and looking at new technologies to see if any of them can make better solutions feasible at scale.

Approaching technology with a focus on learning solutions helps ensure that schools and systems don't waste money on cool-looking yet ineffectual products—and, perhaps even more important, helps avoid wasting teacher and student time. In Chapter 5, we'll look at how to think about this at a larger scale.

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