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EDUCATORS LOVE DIGITAL DEVICES, BUT THERE'S LITTLE EVIDENCE THEY HELP CHILDREN—ESPECIALLY THOSE WHO MOST NEED HELP.

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In a first grade classroom I visited a few years ago, most of the six-year-olds were using iPads or computers. They were working independently on math problems supposedly geared to their ability, while the teacher worked separately with a small group. I watched as one boy, whom I'll call Kevin, stared at an iPad screen that directed him to "combine 8 and 3." A struggling reader (like almost all his classmates), he pressed the "Listen" button. But he still didn't try to provide an answer.

"Do you know what *combine* means?" I asked. Finding that he didn't, I explained it meant "add." Satisfied that I'd put Kevin on the path to success, I moved on to observe other students—and found their iPads displaying sentences like *Round 119 to the nearest ten* and *Find the area of the following triangle in square units.* If Kevin didn't understand *combine,* were other kids understanding words like *round* and *area*? Not to mention *square units*?

Then I found a boy staring at a computer screen showing a number line with the question *What number comes before 84?* He listened to the instructions and tried 85, then 86, then 87, getting error messages each time. Thinking the problem was the size of the numbers, I

asked him what number comes before four. "Five?" he guessed. It dawned on me that he didn't understand the word *before.* Once I explained it, he immediately clicked on 83.

I returned to Kevin to see whether he had been able to combine 8 and 3. But I found he was drawing bright pink lines on the iPad with his finger—one of the gizmo's numerous distracting capabilities.

"Can you answer the question?" I asked.

"I don't want to." He sighed. "Can I play a game?"

The school that Kevin and his classmates attend, located in a poor neighborhood in Washington, DC, prides itself on its "one-to-one" policy—the increasingly popular practice of giving each child a digital device, in this case an iPad. "As technology continues to transform and improve our world," the school's website says, "we believe low-income students should not be left behind."

Schools across the country have jumped on the education technology bandwagon in recent years, with the encouragement of technophile philanthropists like Bill Gates and Mark Zuckerberg. As older education reform strategies like school choice and attempts to improve teacher quality have failed to bear fruit, educators have pinned their hopes on the idea that instructional software and online tutorials and games can help narrow the massive test-score gap between students at the top and bottom of the socioeconomic scale. A recent Gallup report found that 89% of students in the United States (from third to 12th grade) say they use digital learning tools in school at least a few days a week.

Gallup also found near-universal enthusiasm for technology on the part of educators. Among administrators and principals, 96% fully or somewhat support "the increased use of digital learning tools in their school," with almost as much support (85%) coming from teachers. But it's not clear this fervor is based in evidence. When asked if "there is a lot of information available about the effectiveness" of the digital tools they used, only 18% of administrators said yes, along with about a quarter of teachers and principals. Another quarter of teachers said they had little or no information.

In fact, the evidence is equivocal at best. Some studies have found positive effects, at least from moderate amounts of computer use, especially in math. But much of the data shows a negative impact at a range of grade levels. A study of millions of high school students in the 36 member countries of the Organisation for Economic Co-operation and Development (OECD) found that those who used computers heavily at school "do a lot worse in most learning outcomes, even after accounting for social background and student demographics." According to other studies, college students in the US who used laptops or digital devices in their classes did worse on exams. Eighth graders who took Algebra I online did much worse than those who took the course in person. And fourth graders who used tablets in all or almost all their classes had, on average, reading scores 14 points lower than those who never used them—a differential equivalent to an entire grade level. In some states, the gap was significantly larger.

A 2019 report from the National Education Policy Center at the University of Colorado on personalized learning—a loosely defined term that is largely synonymous with education technology—issued a sweeping condemnation. It found "questionable educational assumptions embedded in influential programs, self-interested advocacy by the technology industry, serious threats to student privacy, and a lack of research support."

Judging from the evidence, the most vulnerable students can be harmed the most by a heavy dose of technology—or, at best, not helped. The OECD study found that "technology is of little help in bridging the skills divide between advantaged and disadvantaged students." In the United States, the test score gap between students who use technology frequently and those who don't is largest among students from low-income

COLLEGE STUDENTS WHO USED LAPTOPS OR DIGITAL DEVICES IN THEIR CLASSES DID WORSE ON EXAMS. EIGHTH GRADERS WHO TOOK ALGEBRA I ONLINE DID MUCH WORSE THAN THOSE WHO TOOK THE COURSE IN PERSON.

families. A similar effect has been found for "flipped" courses, which have students watch lectures at home via technology and use class time for discussion and problem-solving. A flipped college math class resulted in short-term gains for white students, male students, and those who were already strong in math. Others saw no benefit, with the result that performance gaps became wider.

Even more troubling, there's evidence that vulnerable students are spending *more* time on digital devices than their more privileged counterparts. High school students in questionable online "credit recovery" courses are disproportionately likely to be poor or members of minority groups (or both). "Virtual" charter schools—which offer online classes and generally produce dismal results—often enroll struggling students. A national charter network called Rocketship Public Schools, which serves low-income communities, relies heavily on technology, with even students in kindergarten spending 80 to 100 minutes a day in front of screens. One study found that in schools serving relatively affluent populations, 44% of fourth graders never used computers, compared with 34% in poorer areas.

The dangers of relying on technology are also particularly pronounced in literacy education and at early grade levels. Unfortunately, to judge from my observations of classrooms at high-poverty schools like the one Kevin attends, that's exactly how and when digital devices are commonly used. The bulk of the elementary school day—three hours or more, at some schools—is spent on "reading" and the rest on math. Especially in schools where standardized reading and math scores are low, subjects like social studies and science have largely disappeared from the curriculum. And the standard class format is to have students rotate through "centers," working independently on reading and math skills while the teacher works with a small group. In the classrooms I've been in, at least one of the centers always involves working on a digital device.

Why are these devices so unhelpful for learning? Various explanations have been offered. When students read text from a screen, it's been shown, they absorb less information than when they read it on paper. Another frequently cited culprit is the distraction the devices afford—whether it's a college student checking Instagram or a first grader like Kevin drawing bright pink lines with his finger. But there are deeper reasons.

One is motivation. If Kevin had been asked to combine 8 and 3 by a teacher rather than an iPad, there's a greater chance he would have been interested in trying to do it. "It's different when you're learning from a person and you have a relationship with that person," cognitive psychologist Daniel Willingham has said. "That makes you care a little bit more about what they think, and it makes you a little bit more willing to put forth effort."

At least one education entrepreneur agrees. Larry Berger is CEO of Amplify, a company that develops digitally enhanced curricula in math, science, and literacy for kindergarten through eighth grade. Berger observes that while technology can do a credible job of imparting information, it's not so good at demonstrating the "social usefulness" of knowledge. "For that," he says, "you have to be getting that knowledge in a social context with other kids and a teacher, and ideally a teacher you want to be like someday." While that may be a problem at schools that use a relatively modest amount of technology, it could be an even bigger one at schools like those in the Rocketship network, where one or two minimally trained supervisors oversee as many as 90 students during "Learning Lab" time. The schools have achieved impressive test results, especially in math, but an NPR investigation in 2016 found a repressive environment at many Rocketship schools. According to some parents and teachers, harsh discipline was used to keep students on task.

In addition to sapping motivation, technology can drain a classroom of the communal aspect of learning. The vision of some ed tech advocates is that each child should sit in front of a screen that delivers lessons tailored to individual ability levels and interests, often on subjects chosen by the students themselves. But a vital part of education is different kids bouncing their ideas off each other. I saw this in action on a regular basis in another, largely technology-free elementary classroom I followed through a school year. Under the guidance of their teacher, second graders—all from low-income families, including many that did not speak English at home—regularly engaged in debates about topics like whether Alexander the Great's "ambitious nature" was "an inspiration or a flaw."

Allowing students to choose the topics they'll learn about can also lead to serious gaps in knowledge for children who don't know much about the world—or even for those who do. One personalized-learning skeptic has observed, "If allowed to choose my own content in elementary school, I would have become an expert in princesses and dogs."

Then there's the difficulty of using technology to meet individual students at their actual level—as evidenced by Kevin's failure to understand the word *combine* and his classmate's difficulty with the word *before*. Children are supposed to take "pre-tests" designed to steer them to software that provides just the right degree of challenge. But kids sometimes forget to take the tests. Even when they do, the program can make faulty assumptions about what they can understand. In a first grade classroom at another school, I observed a group of students using a reading comprehension program. One girl's screen displayed a seemingly random collection of facts about bananas, including "Most bananas come from India." That was followed by a multiple-choice question. Unable to read the word "India," the girl asked a classmate where bananas come from. "From trees," the classmate replied—which was not one of the possible answers.

But even if technology could be calibrated to meet students where they truly are—or to foster communal learning—there's another fundamental problem. Technology is primarily used as a delivery system. Maybe it can deliver instruction better than a human being in some circumstances. But if the material it's delivering is flawed or inadequate, or presented in an illogical order, it won't provide much benefit.

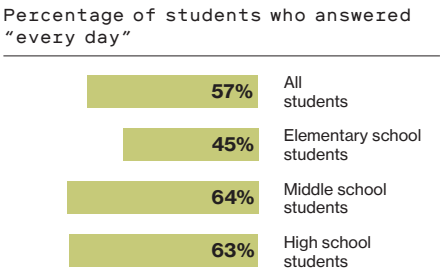
The way Berger puts this is that for most things we want kids to learn, we don't have a "map" that can be used to create software. By that he means, he told me, that in only a few areas is there a clearly defined set of concepts and a cognitively determined sequence in which they should be learned. In math, he said, "there's a developmental stage in which brains are ready to think about part/whole, and if you try to teach fractions before that has happened, that doesn't work." Foundational reading skills are similar: first kids need to learn to match letters to sounds, and then they can learn how to blend those sounds together in sounding out a word. For pretty much everything else, Berger says, we really don't know what should be taught or in what order.

What technology is often used for, especially in elementary schools, is practice in reading comprehension skills. Even in classrooms devoid of technology, children waste hours every week supposedly learning how to "find the main idea" or "make inferences." The content is random—clouds one day, zebras the next—and in any event, it's considered relatively unimportant. Teachers choose books to read aloud based on how well they lend themselves to demonstrating the skill of the week, and students then practice it on books easy enough for them to read independently. When computers and tablets are used, the programs take the same content-agnostic, skills-focused approach. In one classroom, I saw a first grader in front of a screen that displayed a choice of topics including Diwali, fast food, crayons, and Barack Obama. (It turned out the student had neglected to take the pre-test and couldn't read any of the texts.)

But as cognitive scientists have long known, the most important factor in reading comprehension isn't generally applicable skill; it's how much background knowledge and vocabulary the reader has relating to the topic. In a study done in the late 1980s, researchers divided seventh and eighth graders into two groups, depending on how well they had scored on a standardized reading comprehension test and how much they knew about baseball. Then they gave them all a passage about a baseball game. When the researchers tested the kids' comprehension, they found that those who knew a lot about baseball all did well, regardless of how they'd scored on the reading test—and the "poor readers" who

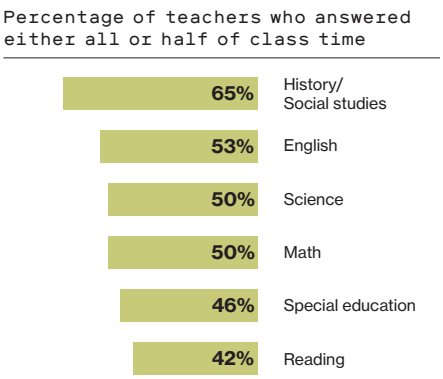
Most students in the US are using ed tech tools every day

Question:
How often do you use digital learning tools?



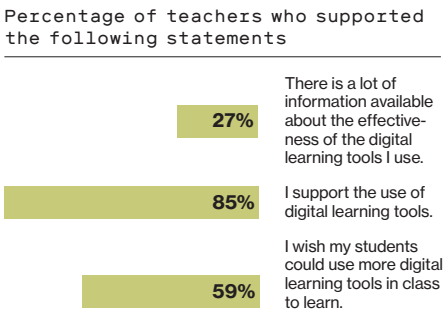
Teachers use digital learning tools across subject matter

Question:
On a typical day, how much class time do you spend using digital learning tools to teach the following subjects?



SOURCE: "EDUCATION TECHNOLOGY USE IN SCHOOLS"; GALLUP. REPRESENTATIVE SAMPLES OF 3,210 AMERICAN PUBLIC SCHOOL TEACHERS AND 2,696 STUDENTS WERE SURVEYED IN EARLY 2019. SAMPLING ERROR IS JUST OVER 2%. DIGITAL LEARNING TOOLS ARE DEFINED AS "WEBSITES, APPS, ONLINE TUTORIALS, ONLINE GAMES AND VIDEOS OR PROGRAMS USED TO TEACH AND SUPPORT STUDENT LEARNING AND SCHOOLWORK."

Teachers don't know much about how well digital tools work, but they support using them



knew a lot about baseball did significantly better than the "good readers" who didn't. That study, which has been replicated in a number of other contexts, provides compelling evidence that knowledge of the topic is more important to comprehension than "skills."

That means the way to build reading comprehension is to adopt a curriculum that has kids spending at least a couple of weeks on a particular topic, to build knowledge and the vocabulary that goes with it. That's especially true for children from less educated families, like Kevin and his classmates, who are unlikely to pick up much sophisticated knowledge at home—and may lack even basic vocabulary like *before*.

Could technology help build knowledge? Perhaps. Software designed on principles drawn from cognitive science has been shown to boost retention and even critical thinking, when harnessed to a particular body of information. Amplify, unlike most other ed tech companies, publishes content-rich curricula for both reading and science. But Berger is wary of using technology as what he calls a "practice/memorization/automaticity support."

"The fear I have there," he says, "is does learning get reduced to that?" In which case you might again confront the motivation problem.

So what role *does* Berger see for ed tech? Rather than asking "What are the parts of education that a computer can do instead of a human?" he thinks the question should be "What are teachers trying to do, and how do we help them do those things?" That means giving them a better understanding of what's going on in the classroom, saving them time, and enabling them "to reach more kids directly more often."

The example he gives is a classroom where—as is not uncommon—there's a wide range of abilities. Rather than the frequently taken approach of giving different students material of differing levels of complexity, Berger says, it's better to give all kids the same content. That would enable all students to grapple with the same information. But he suggests then assigning them different tasks depending on their abilities. All students could be reading the Declaration of Independence, for example, but the more able writers might be told to compose an essay, while others could be asked to write one or more sentences, each one focusing on a key aspect of the document. For many teachers, that kind of "differentiation," as it's called, is very hard. Berger claims technology makes it easier to group students by ability, give them appropriate tasks, and assess their performance. Plus, he says, "it's all invisible at the student level." With computers, kids don't know who is in which group.

That's a far more modest role for education technology than most in the sector have advocated—possibly too modest. Videos and audio recordings can help bring topics to life or give kids access to texts they would struggle to read for themselves. Online textbooks can be easily updated. Math software could be used to facilitate debate between students who arrive at different answers to the same problem. Technology can also enable motivated, gifted students who might be bored in class to race ahead of their peers or take online lessons that aren't taught at their school.

Still, recognition seems to be growing that technology can be counterproductive. Suburban Baltimore County began abandoning textbooks and paper five years ago, with the goal of attaining a one-to-one ratio of devices to students. But test scores have slipped, and parents are skeptical that the move to screens is helping kids learn. Partly in response to complaints, the district decided to use fewer computers in the early elementary grades, adopting a one-to-five ratio instead. Lower-income parents may be having doubts too: Rocketship had to drop plans to open a third school in Washington, DC, after only 22 students signed up.

Educators and reformers aiming to advance educational equity also need to consider the mounting evidence of technology's flaws. Much attention has been focused on the so-called digital divide—the relative lack of access that lower-income Americans have to technology and the internet. That's legitimate: Kevin and students like him need to learn how to use computers to access information online and, more generally, to navigate the modern world. But let's not create a digital divide of the opposite kind by outsourcing their education to devices that purport to build "skills" while their peers in richer neighborhoods enjoy the benefits of being taught by human beings.

Natalie Wexler is the author of The Knowledge Gap: The Hidden Cause of America's Broken Education System—And How to Fix It.