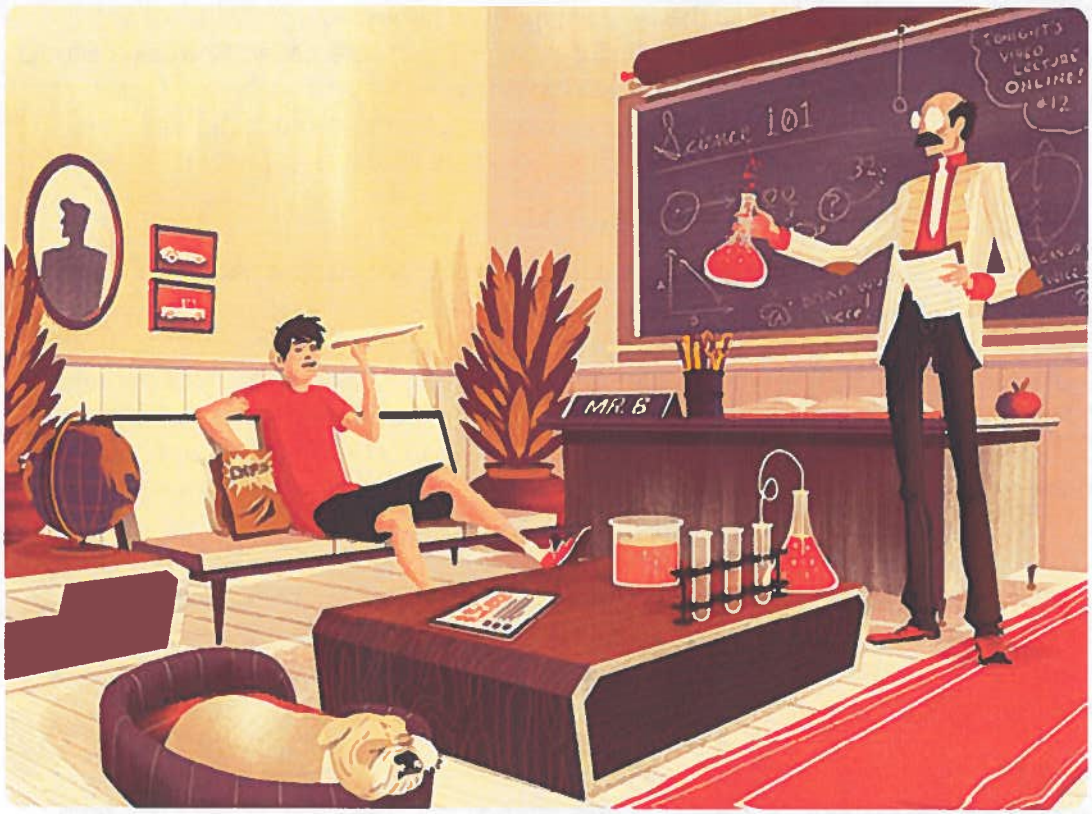
From *Spirit Southwest Airlines*



In the Digital Age, learning is no longer fundamental—at least as it was defined by the old school. Now, some basics of education are being rethought, and the meaning of "homeroom" has changed forever.

By Jennifer Miller

Illustration by Orlin Culture Shop

In September 2010, Marc Seigel, a chemistry teacher at Middletown High School South, in a middle-class enclave of northern New Jersey, thought he'd found a way to engage students who'd rather text under their desks than pay attention to him. In a publication from the National Science Teachers Association, Seigel read about the so-called flipped classroom, a forward-thinking educational model that inverts the norm: What would customarily be defined as homework (problem sets, essay writing, etc.) is done by students during class hours, with a teacher's supervision and hands-on input; and what was once the core of the classroom experience (teacher lectures, delineated lesson plans) is now absorbed at home via video tutorials.

After teaching in the traditional way for 10 years, Seigel had grown bored. The 35-year-old is short, stocky, and balding, but far less nebbishy than he appears. In front of a group of kids, he's a fast-talking fireball, not unlike the famously motormouthed Micro Machines pitchman from the '80s; he's even got the guy's mustache.

Of course, Seigel's students wouldn't get the reference. Their generation grew up playing multimedia digital games. So Seigel got hold of screencasting software called Camtasia Studio and turned each of his lessons into a video podcast that incorporated his voice-over, graphics, some basic animation, and a calculator that solved sample problems in real time. Then he uploaded the videos to YouTube and iTunes and instructed his students to study them each night.

The kids loved the novelty of plugging in for their at-home work. They appreciated the flexibility of stopping and/or rewinding the lesson at any point.

Meanwhile, in the classroom, Seigel was free to give his students significantly more personal attention. "In the past, I couldn't get to every kid, so the quiet ones slipped through the cracks," he says. "Now I was moving around the room like a hummingbird, checking students' work on the spot. It made for a more meaningful interaction because immediately I could make them aware of what they were doing right and wrong."

But the enthusiasm lasted only a few weeks. It's true that Seigel was spending more time with individual students, but he wasn't sufficiently challenging them. "I got bored real fast, and my kids started to slack off," he says. He'd run into a common problem for first-time flippers: the mistaken belief that technology is a silver bullet.

Justin Reich is a fellow at Harvard's Berkman Center for Internet and Society, and the founder of EdTechTeacher, a professional development consultancy that trains teachers to use tech effectively. The goal of flipping a classroom, he says, is not to bend education to the digital proclivities of kids, but to maximize student-teacher interaction during the most demanding lessons. "It's about how we use our time more than how we use our technology," Reich says.

Educators like Reich, who advocate for tech in the classroom, say that the first step in rethinking how we teach should be a renewed examination of how kids learn. Before we fall down the techno–rabbit hole and demand tablets in every classroom, we need to seriously reconsider, for example, whether teaching content, as opposed to cognitive skills, can adequately prepare our children for 21st-century professions. In other words, our nation's educational mindset—one that traditionally uses fact-regurgitation as a marker of success—desperately requires a reboot.

"Before, you could say to a kid, 'You can be a lawyer or a doctor.' The kinds of jobs available were finite," explains Seigel. "This isn't true anymore. Rapid technological development means that many students"—as opposed to seasoned professionals—"will be at the forefront of innovation in their fields." He finds the current state of public-school education distressing. "Kids see the world changing, but the school doesn't change," he says.

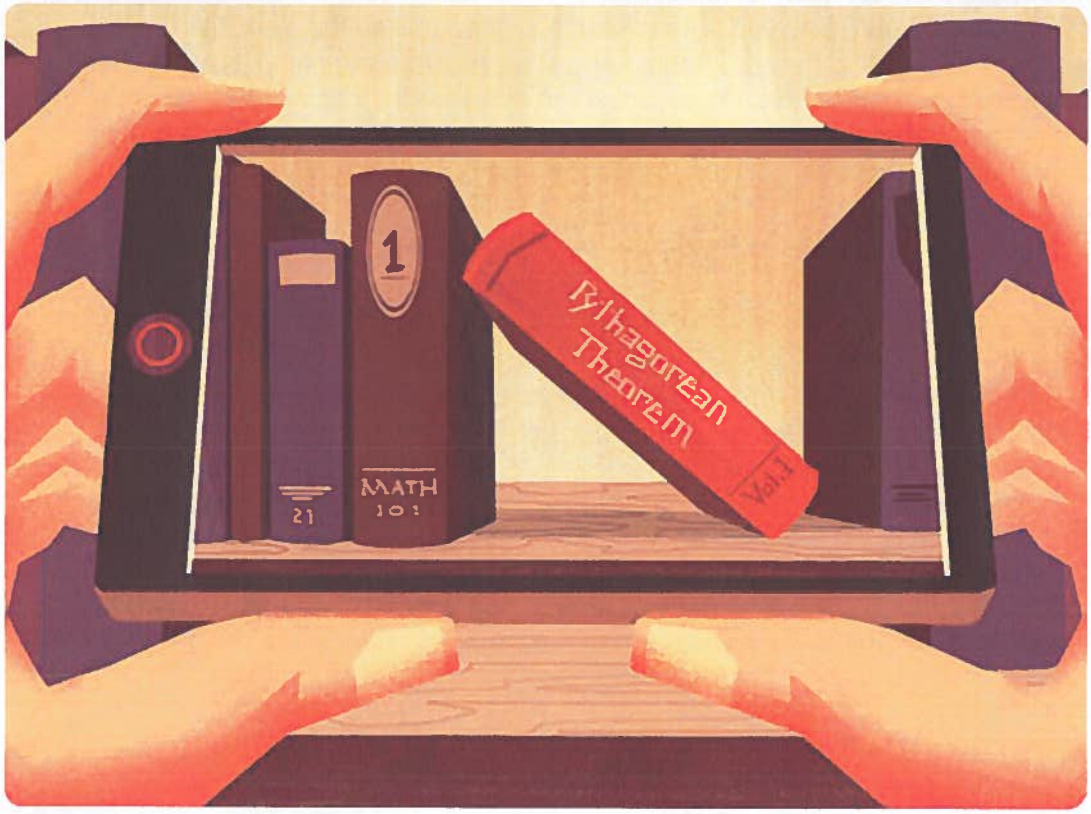
Many teachers want to emphasize independent thinking, but primary-school curriculums are still largely geared toward "teaching to the test." According to Dr. Gary Small, a neuroscientist at UCLA and author of iBrain: Surviving the Technological Alteration of the Modern Mind, this model is long out-of-date. As a society, he says, "we're no longer memorizers but gatherers."

Of course, students still need to learn the basics of math, reading, and science, but people at the helm of the flipping movement believe there's so much more to education. "We need to create kids who are adaptable and who, when faced with a new problem, can solve it with whatever resources they have," says Jon Bergmann, who helped pioneer the flipped classroom model and co-authored the book *Flip Your Classroom: Reach Every Student, in Every Class, Every Day*.

Marc Seigel has become a disciple of Bergmann and his co-author, Aaron Sams. He calls their book his bible. "I carry it with me everywhere I go," he says proudly. But he is just one of two teachers at Middletown South who have experimented with the flipped model. He fought to get his school's cellphone ban overturned and requested that each student's academic career be catalogued through Google Apps. Largely due to Seigel's advocacy, every student in his school district—even kindergartners—now gets a Google account in which to store their work and let parents and teachers follow their progress.

Seigel is not modest about his accomplishments; he boasts that he is the only teacher at his school who has drastically rethought his pedagogical approach. But beyond flipping the home/schoolwork equation, what exactly is this new modus operandi that Bergmann and his followers espouse? Haven't we always aspired to make our students adaptable, resourceful problem solvers? What's so revolutionary about that?

In the flipped philosophy, "problem solving" carries expansive new meaning. And to begin to understand it, it's important to know some basics about how the brain learns, and about how our minds absorb, retain, process, and apply information.



Lesson #1: The Brain Likes New Stuff

In part, Seigel decided to flip his classroom because his students weren't paying close enough attention in school. "Our brains become accustomed to a certain level of stimulation," says neuroscientist Small. "If [media- and technology-immersed] kids are multitasking and stimulated in a certain way outside of school, it's hard for traditional learning models to compete."

Lesson #2: Use It or Lose It

The more crunches we do, the stronger our abs get, but once we quit doing them our muscles atrophy. The brain is similar. "If you spend a lot of time with a particular mental experience," Small says, "the neurocircuits that control the experience will strengthen. But if you don't continue to exercise those circuits, they become rusty."

Dr. Judy Willis, a neurologist and adjunct professor at the University of California, Santa Barbara, who has also taught elementary and middle school, says that knowledge learned via memorization is particularly susceptible to the "use it or lose it" phenomenon. "The brain's procedural memory will only be activated in the way that memory was first learned," she says. Translation: We learn to play a musical instrument, speak a language, or sail a boat by actively practicing these skills. In contrast, students who absorb information specifically for a test can usually only recall that information *for* the test.

The trick, Willis says, is to "connect students' memory of a lesson to another set of circuits that get activated more frequently." Say you're teaching the Pythagorean theorem. Willis would instruct students to walk around their bedrooms and snap pictures of right angles. In class, they'd use these images, along with their textbooks, to solve for the hypotenuse. Then, every time the kids see the objects they photographed—or even similar objects—outside the classroom, their brains will recall the Pythagorean theorem.

Lesson #3: The Brain Gets High On Participation

The previous learning experiment works because it's fun. And when we experience pleasure, our brains release a neurotransmitter called dopamine. "The brain is a dopamine junkie," says Willis. "It wants to remember things that release it." She says that active participation (for example, photographing those right angles) is by far the best way to encourage this.

When students aren't actively engaged, they're more likely to tune out. That's the problem with lecture-based teaching. It doesn't matter whether students are watching a lecture in person or via video. Which is why Seigel's first attempt at flipping his classroom failed. "Watching video is a passive experience," Small says. Instead, teachers should compel students to make decisions throughout every lesson. "That's what activates the neurons," he says.

Willis thinks video games are addictive precisely because they force players into an active state of decision making, thereby fueling the constant release of dopamine. But making predictions—the phrase Willis uses to describe the strategic-thinking process—isn't just about chemical release. It encourages students to think about "what they can do with the information they're presented and how they can use it beyond their school years," she says.

Lesson #4: The Brain Needs Feedback

"For the dopamine reward system to work, feedback needs to be immediate," Willis says. In a video game you know right away if you've succeeded in beating a level. But even if you fail, you've come closer to understanding why. Conversely, students in traditional classroom settings often have to wait a day or two to receive feedback on their homework, and even longer on their tests. If, early on, they get stuck on a problem, they might never finish the assignment.

Willis also talks about the importance of an "achievable challenge." ost effective video games are subtly designed to reinforce a player's confidence; they encourage you to play until you finally succeed. This is why Seigel allows his students to retake tests and why he emphasizes interactive labs over problem sets. It's his adaptation of the achievable challenge model, and a sharp departure from traditional learning, which some say is homogenous in a way that undermines growth. "Some children are not challenged because they've already mastered the knowledge. Others are disengaged because they've failed previously in the subject and do not believe they can succeed," Willis says.

Consequences are becoming particularly dire for the latter type of student.

Over the past three years, Seigel has studied the neuroscience of learning and come to the same conclusions as Small and Willis. He believes that having his students learn through "a kinesthetic approach"—active participation, hands-on projects, etc.—is a better way to reach more students.

On a Friday morning in January, he has prepared a chemistry lab for his college-prep students. It instructs them to, first, measure the number of molecules in a piece of chalk; then, to draw a picture with it; and, finally, to remeasure the chalk's molecules and calculate the difference.

Simple enough, but there's a problem. Only one of Seigel's 15 students has actually done the homework: watching the video podcast he had made explaining the equation.

"Guys!" Seigel groans. "Seriously?" His frustration is remarkably good-humored. Shaking his head as though to say, *Kids these days!*, he waves them off to work.

In pairs, the students weigh the colored chalk and draw pictures on their lab tables—not in notebooks sitting on the tables, but on the tables themselves. This is standard practice for Seigel's class, which is mostly paperless. The kids routinely use dry-erase markers and white boards—or, again, the tables—to record their calculations. They then photograph the work with their smartphones and upload the images to their folders in Google Drive. This helps them organize their work and allows Seigel to check it anytime and anywhere.

During the molecule lab, the teacher roams the room, observing. Flowers, abstract shapes, a cityscape, and something approximating the Death Star from Star Wars appear on the black tabletops. He lingers with a group of shaggy-haired boys, one of whom is listening to music piped through a single earbud. Music is kosher during labs, as long as one of the student's ears is cocked to Seigel's instructions.

"Take it seriously!" he intones. "These drawings should be tweet-worthy." Indeed, a few kids post them to Twitter with the hashtag #chemisawesome.

In other classes, teachers might deem the drawing assignment a waste of time, but Seigel designs his labs to tap into the varied abilities of his students. "The activity covers visual, spatial, interpersonal, and mathematical skills," he says about the molecule lab. "Plus, worksheets are boring, and drawing with chalk is fun."

To complete the second phase of the assignment, the students have to digest the video lesson they'd neglected to watch the night before. They do this at their own pace—some before they've started their drawings, some after. Notably, they don't look to Seigel for direction. Most of the kids huddle around desks—which their teacher has grouped in pods instead of rows—and watch on a laptop. Two girls pull out low-slung mesh chairs, the kind you'd expect to see in a teenager's bedroom, and watch on a smartphone held between them, listening through one earbud apiece.

"I want them to see the classroom as a collaborative environment," Seigel says. Not unlike the kind they'll encounter in the workplace. During the lab, he points to a chart on the wall outlining appropriate classroom usage for personal devices: *yes* to tweeting classwork or looking up questions on Google, *no* to checking Facebook.

"They have a responsibility of policing themselves and policing each other. We're seven weeks into the class, and I've told zero kids to put their phones away," Seigel says with more than a hint of satisfaction.

"This is my child now," says Sammy, 17, gesturing to her new iPhone 5. "I get separation anxiety. I feel like I have my whole life on my phone." She knows Seigel has given her a lot of responsibility, and she embraces it. He has instilled in his students a sense of ownership in the class. "It's about trust," Sammy says.

"Last year in bio, I was constantly reading through books, making notes, and memorizing," says Matt, 16, who takes Seigel's honors chemistry course. "In this class you learn a set of skills, and you apply them."

Importantly, Seigel doesn't mandate specific due dates for each assignment; he gives students suggested guidelines (which most of them follow) and a final date by which all work in the unit must be turned in. At first, kids had trouble with so much freedom.

"I'm a really big procrastinator," Sammy says, admitting that when she first encountered Seigel's flipped style she was always rushing to catch up at the end of the unit. But once she learned to pace herself, the freedom lowered her stress level. Sammy, like most of her peers, has a full extracurricular schedule in addition to schoolwork. "Doing the work on my own time means I can schedule around conflicts," she says. The experience has helped her to manage her time better in other classes, too. "It's a lot of responsibility, but that helps you mature."

Three years into this experiment, Seigel is still adapting and revising. "School is designed around a kid who wants rules and formulas," he admits. "You can't just say, 'Here's everything you need to do. See you in three weeks.' You need to provide [revolving] deadlines and check-ins. This is *a lot* more work."

It's unclear how many teachers in America have introduced 21st-century tech into their curricula or flipped their classrooms, but both are becoming more pervasive. Currently, there are 8 million or so iPads in classrooms across the country, with 3.5 million of those purchased in the last year. Justin Reich, at Harvard, speculates that 2012 was the first time Khan Academy, a nonprofit that offers thousands of free instructional videos on a wide variety of subjects, was widely used for summer homework.

But not everyone believes that students need *more* technology in their lives. No long-term studies exist on the impact of digital multitasking on kids' attention spans, but a recent Pew Research Center survey of more than 2,000 middle school and high school teachers found that 87 percent of them agreed with the assertion that "today's digital technologies are creating an easily distracted generation." Sixty-four percent agreed that "today's digital technologies do more to distract students than to help them academically." Other concerns that teachers attributed to digital "overexposure" included weak time-management skills, a tendency toward procrastination, and the troublesome certitude that tasks can be finished "quickly and at the last minute."

Dr. Small, at UCLA, also wonders how this profligate screen time will affect students' abilities to communicate face-to-face. "They don't look you in the eye. They don't notice verbal cues. Their uni-tasking and empathy skills [are underdeveloped]," he says. Done right, the flipped model addresses all of these problem areas and works to enhance things like teamwork and personalized teacher-student interaction.

With software like Explain Everything, Snagit, Evernote, even iMovie, students can turn assignments and long-term projects into multimedia triumphs. They can receive faster and more direct feedback from their teachers. And they can share and discuss work with their peers more easily. A new digital platform developed at Harvard called Learning Catalytics helps teachers initiate dialogue between students with different points of view. Teachers pose a question to the class, receive their written responses in real time, and then pair up students who can challenge and engage each other.

"Education should give kids the ability to express who they are," says Seigel. "These new technologies let them do that."

In a way, this emphasis on self-expression is about the democratization of education, something the Internet has helped make possible. Take the new trend of Massive Open Online Courses, or MOOCs. Many of these classes let students take free, online courses from major universities. Some of the programs offer certificates. And some, including a new initiative just launched by 40 state schools, will count toward college credit. Theoretically, you could earn a degree for the price of your cable bill.

But this Internet accessibility should not be taken for granted. Some of the country's top schools, including Stuyvesant High School in New York City, have slow, unreliable connections. Marc Seigel's classroom only has a handful of laptops, most of them antiquated, and he is constantly sharing them with other teachers. On a national scale, roughly half of our high school students don't own a smartphone. And many kids still don't have high-speed connectivity at home. The flipped model is impossible without reliable access to the Net.

Financial challenges aside, it also requires tremendous commitment, flexibility, and time to integrate new technologies and teaching practices into classrooms. Seigel finds it hard enough to provide personalized attention to a class of 15 students. But many schools have classes with 30 or more kids. Seigel is similarly lucky to have been supported by his school. He's brash enough—and successful enough—to feel comfortable challenging the system. Many teachers aren't.

Still, the proponents of flipped learning will tell you that educators owe it to their students to find creative solutions to these obstacles. "If a kid can Google the questions on your test and get the answers, is that a valid measurement of learning? No," Seigel says. "It's a measurement of 'I can Google something.' Why does education have to change? Because teachers"—not smartphones—"once were, and should continue to be, the source of learning."

But if a vast universe of information is readily available in cyberspace, what use is today's teacher to students?

Seigel wastes no time in answering. "To teach them," he says, "to think."

Jennifer Miller is a New York–based journalist and author. Her debut novel is The Year of the Gadfly.