



How Khan Academy Is Changing the Rules of Education

By Clive Thompson
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Matthew Carpenter, age 10, has completed 642 inverse trigonometry problems at KhanAcademy.org. Photo: Joe Pugliese

“This,” says Matthew Carpenter, “is my favorite exercise.” I peer over his shoulder at his laptop screen to see the math problem the fifth grader is pondering. It’s an inverse trigonometric function: $\cos^{-1}(1) = ?$

Carpenter, a serious-faced 10-year-old wearing a gray T-shirt and an impressive black digital watch, pauses for a second, fidgets, then clicks on “0 degrees.” Presto: The computer tells him that he’s correct. The software then generates another problem, followed by another, and yet another, until he’s nailed 10 in a row in just a few minutes. All told, he’s done an insane 642 inverse trig problems. “It took a while for me to get it,” he admits sheepishly.

Carpenter, who attends Santa Rita Elementary, a public school in Los Altos, California, shouldn’t be doing work anywhere near this advanced. In fact, when I visited his class this spring—in a sun-drenched room festooned with a papercraft X-wing fighter and student paintings of trees—the kids were supposed to be learning basic fractions, decimals, and percentages. As his teacher, Kami Thordarson, explains, students don’t normally tackle inverse trig until high school, and sometimes not even then.

But last November, Thordarson began using Khan Academy in her class. Khan Academy is an educational website that, as its tagline puts it, aims to let anyone “learn almost anything—for free.” Students, or anyone interested enough to surf by, can watch some 2,400 videos in which the site’s founder, Salman Khan, chattily discusses principles of math, science, and economics (with a smattering of social science topics thrown in). The videos are decidedly lo-fi, even crude: Generally seven to 14 minutes long, they consist of a voice-over by Khan describing a mathematical concept or explaining how to solve a problem while his hand-scribbled formulas and diagrams appear onscreen. Like the Wizard of Oz, Khan never steps from behind the curtain to appear in a video himself; it’s just Khan’s voice and some scrawly equations. In addition to these videos, the website offers software that generates practice problems and rewards good performance with videogame-like badges—for answering a “streak” of questions correctly, say, or mastering a series of algebra levels. (Carpenter has acquired 52 Earth badges in math, which require hours of toil to attain and at which his classmates gaze with envy and awe.)

Initially, Thordarson thought Khan Academy would merely be a helpful supplement to her normal instruction. But it quickly become far more than that. She’s now on her way to “flipping” the way her class works. This involves replacing some of her lectures with Khan’s videos, which students can watch at home. Then, in class, they focus on working problem sets. The idea is to invert the normal rhythms of school, so that lectures are viewed on the kids’ own time and homework is done at school. It sounds weird, Thordarson admits, but this flipping makes sense when you think about it. It’s when they’re doing homework that students are really grappling with a subject and are most likely to need someone to talk to. And now Thordarson can tell just when this grappling occurs: Khan Academy provides teachers with a dashboard application that lets her see the instant a student gets stuck.

“I’m able to give specific, pinpointed help when needed,” she says.

The result is that Thordarson’s students move at their own pace. Those who are struggling get surgically targeted guidance, while advanced kids like Carpenter rocket far ahead; once they’re

answering questions without making mistakes, Khan's site automatically recommends new topics to move on to. Over half the class is now tackling subjects like algebra and geometric formulas. And even the less precocious kids are improving: Only 3 percent of her students were classified as average or lower in end-of-year tests, down from 13 percent at midyear.

For years, teachers like Thordarson have complained about the frustrations of teaching to the "middle" of the class. They stand at the whiteboard, trying to get 25 or more students to learn the same stuff at the same pace. And, of course, it never really works: Advanced kids get bored and tune out, lagging ones get lost and tune out, and pretty soon half the class isn't paying attention. Since the rise of personal computers in the early '80s, educators have hoped that technology could solve this problem by offering lessons tailored to each kid. Schools have blown millions, maybe billions, of dollars on sophisticated classroom technology, but the effort has been in vain.

Khan's videos are anything but sophisticated. He recorded many of them in a closet at home, his voice sounding muffled on his \$25 Logitech headset. But some of his fans believe that Khan has stumbled onto the secret to solving education's middle-of-the-class mediocrity. Most notable among them is Bill Gates, whose foundation has invested \$1.5 million in Khan's site. "I'd been looking for something like this—it's so important," Gates says. Khan's approach, he argues, shows that education can truly be customized, with each student getting individualized help when needed.

Not everyone agrees. Critics argue that Khan's videos and software encourage uncreative, repetitive drilling—and leave kids staring at screens instead of interacting with real live teachers. Even Khan will acknowledge that he's not an educational professional; he's just a nerd who improvised a cool way to teach people things. And for better or worse, this means that he doesn't have a consistent, comprehensive plan for overhauling school curricula.

Whatever Khan's limits, his site has become extremely popular. More than 2 million users watch his videos every month, and all told they answer about 15 questions per second. Khan is clearly helping students master difficult and vital subjects. And he's not alone: From TED talks to iTunes U to Bill Hammack the Engineer Guy, new online educational tools are bringing the ethos of Silicon Valley to education. The role these sites can (or should) play in our nation's schools is unclear. But classes like Thordarson's are starting to find out.

Teachers have long known that one-on-one tutoring is effective, but in 1984, the education scholar Benjamin Bloom figured out precisely *how* effective it is. He conducted a metastudy of research on students who'd been pulled out of class and given individual instruction. What Bloom found is that students given one-on-one attention reliably perform two standard deviations better than their peers who stay in a regular classroom. How much of an improvement is that? Enough that a student in the middle of the pack will vault into the 98th percentile. Bloom's findings caused a stir in education, but ultimately they didn't significantly change the basic structure of the classroom. One-on-one instruction, after all, is insanely expensive. What country can afford one teacher per student?

"We've always known that one-on-one is the best way to learn, but we've never been able to figure out how to do it," Khan explains when we first meet at his small, four-room office in

downtown Mountain View, California. A hoodie-clad 34-year-old with big brown eyes and a mass of jet-black hair, Khan leans back in his chair as he talks, cracking a steady stream of jokes. He has a kinetic sort of wit; he's like a nerdy, South Asian-American Seinfeld, except for the occasional "y'all" that punctuates his speech, a vestige of a youth spent in New Orleans. His desk is made out of old telephone poles and is scattered with books on investing, physics, and heart disease—subjects for upcoming videos. Khan keeps up a breakneck pace of productivity: He has recorded every one of the videos on the site himself and produces up to eight new ones each workday. His offerings run from the straightforward—science and math topics like "Pythagorean Theorem 2," "Dirac Delta Function," and "Why Gravity Gets So Strong Near Dense Objects"—to the quirky, including a series of muckraking analyses of the Geithner bank bailouts. It helps that he has a ton of formal schooling, including three degrees from MIT (a BS in math and a BS and MS in computer science) as well as a Harvard MBA. But he also frequently goes outside his areas of expertise, hitting Wikipedia, the web, his personal library, and his long list of brainy friends to bone up on new topics until he feels competent. His office contains several *Idiot's Guide to ...* books.

Khan never intended to become an education revolutionary. Talented at math in high school, he initially hoped to be a Richard Feynman-style theoretical physicist, before realizing he was far more likely to make his mark in computers. After finishing at MIT and working for a few Silicon Valley dotcoms, he headed to Harvard Business School in 2001, where he claims his main motivation was to get married. ("I'm dead serious," he says. "Silicon Valley in the late '90s was the absolute worst place to find a wife or a girlfriend." He found one and married her—a med student who's now a doctor in Mountain View.)

After business school, Khan went to work for Wohl Capital, a hedge fund, where he researched companies to find solid investments. At Wohl, he learned how to quickly orient himself in unfamiliar territory. (He also amassed an epic store of mental trivia. While we're having lunch, he casually mentions how many eggs the average chicken lays in a year: "It's 260!") Dan Wohl, his boss, discovered that Khan seemed unusually driven to teach. "I'd come back to the office," Wohl says, "and giant math equations were scrawled across the board." Khan was training the junior staff in the nuances of finance. "It's not the usual cutthroat Wall Street thing to do," Wohl adds. "But he had this natural gift and a really selfless approach."

Then, in 2004, Khan's 13-year-old cousin Nadia, who lived across the country, asked him for help in math. Khan agreed to tutor her on the phone. To illustrate the mathematical concepts he was describing, they'd log into Yahoo Messenger and Khan would use the program's drawing window to write equations while she watched remotely. When they couldn't meet, he'd just record a lesson as a video, talking through the material while writing in Microsoft Paint.

One day Nadia told him she didn't want to talk on the phone anymore; she wanted him to just record videos. Why? Because that way she could review the video as many times as she wanted, scrolling back several times over puzzling parts and fast-forwarding through the boring bits she already knew. "She basically said, 'I like you better on the video than in person,'" Khan says.

A lightbulb went off: Khan realized that remediation—going over and over something that you really ought to already know—is less embarrassing when you can do it privately, with no one

watching. Nadia learned faster when she had control over the pace of the lecture. “The worst time to learn something,” he says, “is when someone is standing over your shoulder going, ‘Do you get it?’”

He also discovered that the state of math education in the country was pretty awful. He began tutoring several other cousins (word had gotten around the family: free lessons!), and he was disturbed to find that their grasp of the basics was shaky. Even on simple division questions, they answered tentatively and slowly. Khan wanted to get the kids to the point where they could confidently bark back these answers—they had to have this kind of automatic mental processing before they could handle more-advanced material.

What his cousins needed, he decided, was drilling. He programmed Java modules that would fire questions at them automatically. If they got 10 questions right in a row, the software would push them to the next level, which had harder problems. (As a bonus, he could peek at the database online to make sure they were actually doing the practice.) Though Khan didn’t know the academic terminology at the time, he was implementing classic “mastery-based learning”—requiring students to prove they’ve conquered material before advancing.



Kami Thordarson uses Khan Academy in her fifth-grade class. Some kids are already learning calculus with it. Photo: Joe Pugliese

Word soon spread to the rest of the world. Khan discovered that thousands of people were watching his videos on YouTube. Some were students mystified by physics, others were adults brushing up on basics before relaunching a stalled college degree. Khan gradually became more

and more absorbed in his site, staying up past midnight crafting new videos and software lessons. Email messages poured in from fans, startling him with their intensity.

“You made me realize that anyone can learn the material when it is presented in the right way,” wrote Tom Brannan, a 19-year-old about to enter a Pennsylvania college. After dropping to a C in math, Brannan learned enough from Khan to ace his last few high school tests and now plans to pursue a degree in computer science. “I had been struggling with the unit circle, essentially trying to learn it out of the textbook,” Brannan wrote. “I watched your videos and it all clicked.”

In 2009, Khan decided to turn his hobby into a full-time job. He formed a nonprofit and got a small donation from Ann Doerr, wife of Silicon Valley investor John Doerr. Demand had taken off; now tens of thousands of people were watching his videos every month. Khan quickly got to work recording more clips in his closet.

Then, last summer, he received a text from Doerr, who was attending the Aspen Ideas Festival: “Bill Gates is talking about your stuff onstage.” Khan dialed up the online video from Aspen and watched Gates, whom he’d never met, singing his praises; indeed, Gates revealed that his own kids were using Khan Academy as a study aid. (“I shit a brick when I saw that,” Khan says.) He met with Gates soon after and received \$1.5 million from the Bill & Melinda Gates Foundation. Google kicked in another \$2 million.

“Math is the killer,” Gates told me recently. His foundation had researched unemployment and found math to be a significant stumbling block. “If you ask people, ‘Hey, there are these open nursing jobs, why don’t you go and get one?’ math is often the reason they give for not applying,” Gates says. “‘Why didn’t you pass the police exam?’ Math.”

In the new era of popular, YouTube-friendly education videos, Khan’s site is unique in that it’s ruthlessly practical: It’s aimed at helping people master the basics, the humble bread-and-butter equations they encounter in elementary and high school. Traditionally, these kinds of videos can be dry and difficult to slog through. But Khan manages to pull off his lessons with a casual air that keeps the viewer engaged. He says his relaxed approach isn’t faked—it’s a result of the way he prepares. He never writes a script. He simply researches a topic until he feels he can explain it off the cuff to “a motivated 7-year-old.” (Preparation can take anywhere from 10 minutes with a familiar subject like algebra to nearly a week in the case of organic chemistry.) Khan also never edits. Either he nails the lecture in a single take or he redoes the entire thing until it satisfies him.

Khan suspects there is a hidden power in the fact that he never appears onscreen in his videos. The only visual is his handwriting, slowly filling the screen. “That way, it doesn’t seem like I’m up on a stage lecturing down at you,” he says. “It’s intimate, like we’re both sitting at a table and we’re working through something together, writing on a piece of paper.”

After you’ve listened to a lot of Khan’s stuff, instructional videos by for-profit educational firms begin to sound gratingly phony. At his desk, he pulls up a YouTube video about how the sodium-potassium pump in a cell membrane works. As the video plays, a singsongy female voice-over fills his office with the cloying, condescending tone of a teacher who’s convinced her students are idiots. “I mean, I can’t pay attention for one minute to that,” he says.

Several students I spoke to also pointed out that Khan is particularly good at explaining all the hidden, small steps in math problems—steps that teachers often gloss over. He has an uncanny ability to inhabit the mind of someone who doesn't already understand something. "He explains things step by step, rather than assuming you already know how to get from A to B," Brannan says.

"It's just super-impressive that Sal explains stuff so well," Gates says. "The fact that one guy can do so many subjects is pretty amazing."

Last November, Khan Academy made the jump from hot new website to actual classroom tool. Khan had coffee with a member of the Los Altos school board who suggested that the district try using Khan's system. Three schools offered up classes as test subjects—two fifth-grade classes (including the one run by Kami Thordarson) and two seventh-grade classes.

Khan thought he could offer teachers crucial new insight into how students learn. He envisioned a dashboard system that would track students' individual statistics, showing them and their instructors how many videos they'd watched, how many questions they'd answered, and which ones they'd gotten wrong or right. Normally, of course, teachers fly blind. They use quizzes, homework, and their own observations to try to figure out how much their students understand, but it's a crude process. Day to day, it's hard to know what a student is and isn't learning. A dashboard, Khan says, can change all that.

In the fall of 2010, flush with the infusion of money from Google and Gates, Khan hired a programmer, Ben Kamens, and a designer, Jason Rosoff, and tasked them with, among other things, building the dashboard. These sorts of performance-measuring apps have become increasingly common in the business world, so the duo didn't think teachers would be terribly impressed by their software. Wrong: They were astounded. "We'd go collect some data and make a chart, and the teachers were blown away—every time," Kamens says. "This isn't taxing the edge of technology. But they were completely shocked, as if this had never existed before."

Among those impressed was Courtney Cadwell, a seventh-grade math teacher at Egan Junior High in Los Altos. When I visited her class, she pulled me over to her laptop and showed me her kids' statistics. She flicked through screenfuls of colorful charts illustrating what subjects the kids were working on and how many videos they'd watched and problem sets they'd done. The software even told Cadwell how many minutes the students had worked at home.

"Oh my gosh," she exclaims when she gets to one student's account. "Kristofer, he's working on systems of equations and subtracting fractions?" Clearly, even after working with the system for almost five months, it still has the ability to surprise her. A look at the data shows that the students seem to advance in spurts: A kid will grind away at a subject, seemingly stuck, until suddenly something clicks and he vaults forward, sometimes going on a tear and mastering several new subjects in a day or two.

Cadwell has already gotten so used to these metrics that she feels unmoored in her other classes, where they're not yet using the system. "In those, I get to a quiz or a test and I'm blindsided when they don't know something—or when they ace something."

Cadwell needs all the help she can get: She teaches remedial math to the school's struggling students, some of whom come from immigrant families with parents who don't speak English and can't easily help with homework. When her seventh-grade class arrived last fall, some barely had third-grade math skills. But by being able to target her students for special help exactly when they needed it, Cadwell saw stunning results: The class's test scores improved more than 106 percent in half a year. One girl I met in the classroom had advanced an astonishing 366 percent. "I hated math," the girl tells me cheerfully. "But now it's actually fun." She began the year unable to do basic fractions; during my visit, I watched her plow through complicated long division, carefully working problems on the Khan software.

Borrowing another trend in software, Khan's team also added gamelike rewards to the interface. They came up with a welter of points, badges, and awards that kids can vie for. The Los Altos teachers were surprised—almost flabbergasted—by how powerfully the rewards motivated their students. When I visited the fifth-grade class of Kelly Rafferty at Santa Rita Elementary, the room teemed with kids milling around the school's laptops, checking out one another's latest achievements and trying to help each other on various modules. Rafferty pointed to a boy pecking away at division problems. "He's done something like 500 multiplication problems," she said. "Could I ever get him to do 500 of anything? No. So it's funny the things that motivate them." She noticed that one student had worked on problems at home from midnight to 2 am the night before.

Of course, kids who've grown up on computers are quick to spot the weaknesses in Khan's system. They discovered ways to cheat on the drills: In the logarithms unit, for example, they noticed that the third multiple-choice answer was always the right one.

Some students also told me they were unsettled by their teachers' ability to monitor precisely how much work they've done. "I just think that's kind of awkward," Maddy Zib, 12, said to Cadwell the day I visited. "It's like you're able to spy on our progress! I know you're the teacher and that's your job ... but it's just a bit weird."

Not all educators are enamored with Khan and his site. Gary Stager, a longtime educational consultant and advocate of laptops in classrooms, thinks Khan Academy isn't innovative at all. The videos and software modules, he contends, are just a high tech version of that most hoary of teaching techniques—lecturing and drilling. Schools have become "joyless test-prep factories," he says, and Khan Academy caters to this dismal trend. Khan's approach "suffers from this sort of 'school über alles' philosophy: They're not going to question anything the schools do. They're not going to challenge any of the content." Stager admires the fact that Khan is trying to improve education, but he says research has shown that kids who are struggling at math won't be helped by a "filmstrip."

As Sylvia Martinez, president of Generation YES, a nonprofit focusing on technology in the classroom, puts it, "The things they're doing are really just rote." Flipping the classroom isn't an entirely new idea, Martinez says, and she doubts that it would work for most kids: If they can't understand the lecture in a classroom, they're not going to grasp it better when it's done through a video at home.



When Matthew Carpenter wants to push ahead, he can watch Khan Academy videos at home. Photo: Joe Pugliese



Salman Khan approaches education with the mindset of a Silicon Valley entrepreneur: Make something cool and people will use it. Photo: Joe Pugliese

Khan's critics are mostly "constructionists." This school of thought holds that kids lose interest in math because it's so often taught as a bunch of mechanical routines you follow to solve problems disconnected from everyday life. Constructionists argue that it's better to give kids activities that let them discover the principles of math and physics on their own—for instance, having them play around with kid-friendly programming languages like Logo. "Students 'fumbling around' is actually where the learning happens—and there's no shortcut for this process," Martinez wrote in a blog post savaging Khan's system. Gates and Khan claim they're trying to shake up the classroom, but Khan's critics say he's not being radical *enough*.

As you might imagine, Khan heatedly rejects the notion that he's promoting a return to rote learning. "It's the exact opposite!" he says: The more that teachers flip their classrooms—with students watching his lectures at home—the more time is freed up for creative activities during the school day, like arts, games, or collectively brainstorming more abstract stuff. "You're actually liberating the classroom; you're making it more human," he says. He takes a dim view of the constructionist idea that students won't really understand math unless they discover each principle on their own. "Isaac Newton would not have invented calculus had he not had textbooks on algebra." Bill Gates is even more scathing: "It's bullshit," he says. "If you can't do multiplication, then tell me, what is your contribution to society going to be?"

Another limitation of Khan's site is that the drilling software can handle only subjects where the answers are unambiguously right or wrong, like math or chemistry. And Khan has relatively few videos on messier, gray-area subjects like history.

And Khan and Gates both admit there's no easy way to automate the teaching of writing—even though that subject is just as critical as math and students score equally poorly on it in national tests. Khan thinks one way to teach writing online is with peer review—have kids upload their writing so that the entire class can read and comment on it. (Many teachers, in fact, already do this.) In the next year or so, he wants to launch a community section of Khan Academy, where students can help each other with writing. He envisions students posting questions they can't solve and getting guidance from other students or teachers around the world, any time of day; those who offered the best help would get voted upward.

Even if Khan is truly liberating students to advance at their own pace, it's not clear that the schools will be able to cope. The very concept of grade levels implies groups of students moving along together at an even pace. So what happens when, using Khan Academy, you wind up with a kid in fifth grade who has mastered high school trigonometry and physics—but is still functioning like a regular 10-year-old when it comes to writing, history, and social studies? Khan's programmer, Ben Kamens, has heard from teachers who've seen Khan Academy presentations and loved the idea but wondered whether they could modify it "to stop students from becoming this advanced."

Khan's success—and tech-darling status—has injected him into the heated wars over school reform. Reformers today, by and large, believe student success should be carefully tested, with teachers and principals receiving better pay if their students advance more quickly and getting canned if they fall behind. They're generally in favor of privately run charter schools and hotly opposed to the seniority rules of the teachers' unions, if not the existence of unions altogether.

Though the ranks of reformers include many Wall Streeters and Silicon Valley honchos, Khan himself winces when I apply the label to him. He says he has no particular animus toward the public school system; in fact, his experience with Los Altos has shown him that public school teachers can be as innovative as anyone else. “Don’t call me an education reformer, all right?” he says. “We’re not out to fight some political battle. We’re out to build stuff that’s useful.”

Khan doesn’t seem to care whether he changes the school system. Indeed, he’s leery of working too closely with school districts, because it would require him to adhere to their rules and expectations. Until now, he has followed his own instincts in building his library of videos and software—recording the subjects his cousins needed, then gradually adding those that he found interesting or that he thought students would benefit from. But schools have a firm curriculum they have to march through, and the Los Altos teachers often find they’re moving on to subjects that Khan hasn’t covered in detail.

Khan is gamely attempting to fill those holes. But he’s not breaking his back, because he doesn’t want the school system and its byzantine standards determining what he does with his site. Indeed, he argues, trying to serve taskmasters in different districts in 50 states is one of the reasons so many educational software companies produce such dull sludge: Much like teaching to the mythical “middle” of a class, the process strips teaching materials of any eccentricity and playfulness. “I don’t want to be a vendor,” he says with a shrug.

In essence, Khan doesn’t want to change the way institutions teach; he wants to change how people learn, whether they’re in a private school or a public school—or for that matter, whether they’re a student or an adult trying to self-educate in their kitchen in Ohio. Or Brazil or Russia or India: One member of Khan’s staff—now up to 13 people—is spearheading a drive to translate the videos into 10 major languages. It’s classic startup logic: Do something cool, do it quickly, and people who love it will find you.

In the spring, Cadwell’s principal visited her classroom to see how Khan Academy was working out. The students were watching a video with their headsets on. Each was viewing it in a slightly different way, pausing and rewinding the parts that confused them and writing down notes—which is precisely what customized learning ought to look like. But Cadwell realized that, as she sat there watching, she—the teacher—appeared to be slacking. “It was just very weird when the kids had their headphones on, all watching the same video and listening to the same information, but I wasn’t in control of it!” she says.

But the principal didn’t object. As more high-quality lecture materials go online, teachers and administrators alike are beginning to realize that when it comes to simply explaining something, there’s probably someone out there who’s doing it better. So, they tell me, why compete? Focus instead on offering the sort of fine-grained, personalized help that only a live teacher can offer.

As it happens, even some teachers who’ve never heard of Khan Academy are already practicing some of Khan’s ideas: They flip their classrooms and use free tools like Google Docs to make their students’ learning as visible and trackable as possible. Many teachers are resourceful, and they’ll use any tool at their disposal—sanctioned or not. It could be that the kind of fundamental

changes promised by sites like Khan Academy are going to upend the classroom, no matter what happens at the district or state level.

For his part, Khan says he's now considering starting his own private school, as a way to see just how much you could wrap learning around Khan Academy. His ideas are intriguing: Among other things, his school wouldn't divide kids by age; teenagers would mix in with kindergartners. "I have no research to back this up," he says, "but younger kids act more mature around older kids, and older kids act more mature around younger kids." If the classrooms were fully flipped, students could spend more of the school day doing creative activities. He'd use board games to teach negotiation, and he'd teach history backward. ("Why are the Israelis and Palestinians pissed at each other? Let's go back a couple of years. Wait—they were pissed at each other even then! So you go back even further ...") He also thinks he'd teach kids subjects that have more real-world applicability—like "statistics, law, accounting, and finance. Why are you teaching people civics? Teach them law. That's more relevant, and you learn civics at the same time." He calculates that it would cost only \$10,000 per child, "affordable for professional couples out here."

If Khan does start such a school, he'll have a powerful advantage. He's been posting videos online for five years and students have answered more than 50 million questions in his software: Khan and his team are now sitting on a massive pile of data about how people learn and where they get stuck. He plans to mine the information to discover previously invisible patterns. How many times do students need to view the statistics video before they can answer questions about the subject? If you examine all the kids who stumble on, say, fractional division and basic algebra, can you predict what other subjects they'll have trouble mastering? In the long run, Khan believes, such data mining could help him create customized lessons that are perfectly keyed to each kid's learning style.

But in the meantime, he's got videos to record. Back at his office, he slips on his headset. His next video will be about diabetes, and he'll use the subject to sneak in some tricky, Khan-style math—calculating how many teaspoons of sugar are floating around in your bloodstream. "It's almost 1 teaspoon per average-size human at any point in time!" he says somewhat gleefully. Then he turns around, hits the record button, and starts talking.

Contributing editor Clive Thompson (clive@clivethompson.net) is currently at work on Outsmart, a book about how digital tools change the way we think.

Cool Schools

The Khan Academy isn't the only site changing the way we learn—and teach. From lessons on quantum mechanics that can be downloaded to your mobile phone to museum-produced video lectures on expressionism, here are a few other online tools helping to reshape education.

— Rachel Swaby



ENGINEER GUY

In his dazzling video series, University of Illinois engineering professor Bill Hammack explains the workings of everyday objects—like a computer hard drive or a lightbulb.

engineerguy.com

CONNEXIONS

This open source site lets users assemble educational materials—videos, documents, charts—in one place. Called knowledge chunks, these lessons can then be shared with the public for revising and remixing.

cnx.org



ITUNES U

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apple.com/education/itunes-u

GOOGLE CODE UNIVERSITY

Computer science students and educators can access tutorials, courses, and videos on web programming, distributed systems, and other Google-related fare. Many courses were developed by Googlers themselves.

code.google.com/edu



MOMA'S MODERN TEACHERS

The Museum of Modern Art offers free guides, lessons, and images on topics like futurism and artists like Eva Hesse and Roy Lichtenstein.

moma.org/modernteachers

PBS TEACHERS

PBS has compiled a media library for students and teachers, broken down by subject and grade level. Topics range from how to do a handstand to conservation of angular momentum.

pbs.org/teachers



YOUTUBE EDU

This handy YouTube channel hosts more than 125,000 free instructional videos from universities and independent educators like the Khan Academy.

youtube.com/edu