MIT Technology Review
BUSINESS REPORT

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Online Learning

Technology can now gather tremendous amounts of data about how we learn. What is that teaching us?

GARY TAXALI

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The Big Question

Lessons from the Digital Classroom

Technologists and venture capitalists are betting that the data online learning generates will reshape education.

● In four small schools scattered across San Francisco, a data experiment is under way. That is where AltSchool is testing how technology can help teachers maximize their students' learning.

Founded two years ago by Max Ventilla, a data expert and former head of personalization at Google, AltSchool runs schools filled with data-gathering technology.

Information is captured from the moment each student arrives at school and checks in on an attendance app. For part of the day, students work independently, using iPads and Chromebooks, on "playlists" of activities that teachers have selected to match their personal goals. Data about each student's progress is captured for teachers' later review. Classrooms are recorded, and teachers can flag important moments by pressing a button, as you might TiVo your favorite television show.

The idea is that all the data from this network of schools will be woven into a smart centralized operating system that teachers will be able to use to design effective and personalized instruction. There is even a recommendation engine built in.

While most schools don't have the type of technology AltSchool is developing, classrooms are increasingly filled with laptops and other digital teaching aids. This year U.S. elementary, middle, and high schools are expected to spend $4.7 billion on information technology. What is new is that many of the technologies are capturing expansive amounts of data, enough of it to search for meaningful patterns and insight into how students learn. The potential for that to be turned into profit is a big reason investors have increased funding of educational technology startups worldwide, from $1.6 billion in 2013 to $2.4 billion in 2014; they invested over $1 billion more in the first quarter of 2015, much of that in China. What all that data is teaching us about how we learn and whether technology is actually making instruction better are the big questions at the heart of this Business Report.

At the AltSchools, where tuition can exceed $20,000 a year, the goal is to create highly individualized instruction built on a system that can grow to reach a broad scale. Four more AltSchools are opening this fall, including one in Brooklyn, New York, and Ventilla hopes to eventually sell access to the system to other schools, too. AltSchool has raised $133 million from the likes of Facebook founder Mark Zuckerberg, venture capitalist John Doerr, the Omidyar Network, and venture firms Andreessen Horowitz and Founders Fund. "What if we tried to create not just great schools we'd like to send our kids to, but an expanding ecosystem?" says Ventilla, who started thinking about education when he and his wife began applying to preschool for their daughter in 2012. "What role can technology play to superpower each child and each set of parents and educators?"

Similar experiments are under way in colleges as well. In the seven years since the first "massive open online course," Connectivism and Connective Knowledge, was taught by two Canadian educators, Stephen Downes and George Siemens, MOOCs have become a source of tremendous amounts of data about students' behavior. Examination of this data has intensified since 2012, when the three largest platforms for these classes were launched: the Harvard-MIT joint venture edX and two for-profit companies founded by former Stanford professors, Udacity and Coursera. Between the fall of 2012 and the summer of 2014, more than a million people participated in the 68 open online courses on edX, logging 1.1 billion clicks on the edX servers.

While only a small percentage of students complete any given MOOC, their data is helping educators develop new teaching models that promise to be more effective—such as programs that combine online instruction with one-on-one coaching or support, regular quizzes, and other check-ins on progress.

This approach has been shown in some cases to be more successful than traditional classroom instruction. Arizona State University, for example, offers more than 90 different undergraduate and graduate degrees online, part of a

Online Learning Over Time

An abbreviated history of learning over the Web.

1992
The Electronic University Network offers a PhD via America Online.

1996
Western Governors University, initially funded by 11 states, begins offering courses online. By 2015 its programs will graduate 10,000 students a year.

2003
Eighty-one percent of colleges offer at least one course online.

2008
First massive open online course (MOOC) is taught, and Salman Khan launches Khan Academy, the nonprofit free tutorial site.

2011
Sebastian Thrun and Peter Norvig's MOOC Introduction to Artificial Intelligence opens a Stanford classroom to the Web. Initial enrollment: over 150,000.

2012
The *New York Times* declares 2012 the "Year of the MOOC" after the launch of edX, a nonprofit joint venture of Harvard and MIT, and the private companies Udacity and Coursera.

2013
Georgia Institute of Technology offers first MOOC-based master's degree, in computer science.

2015
Arizona State University begins offering full freshman college credit for certain MOOCs.

long-term goal as a public university of expanding access to education. The university teaches freshman math to 8,000 students a year. Those needing to catch up to college level are placed in Developmental Math, a class where 50 percent of students have traditionally earned a D or F.

Four years ago ASU combined its online and classroom approaches to Developmental Math, switching to video-based lectures and incorporating an online tool made by a company called Knewton. It analyzes students as they work through online math lessons to understand how they learn best and what they have and have not mastered. Reports on students' progress, the time they are putting in, and their engagement and success then go to student coaches who reach out by e-mail, text message, or in person. In the first two semesters the school used this approach, the pass rate increased to 75 percent.

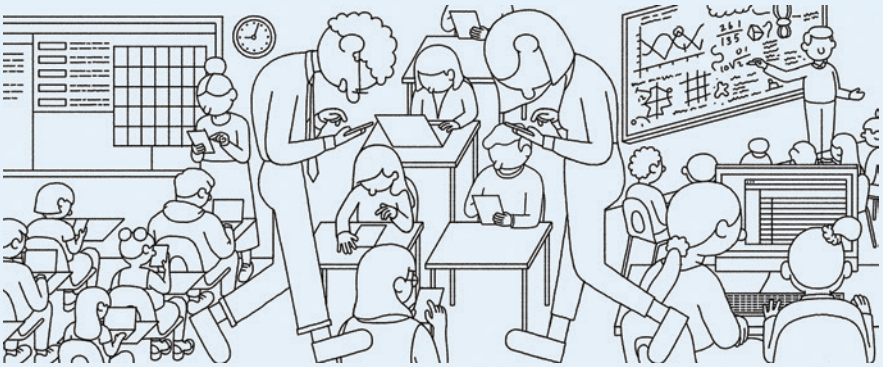
Udacity has similarly structured itself around individualized feedback. In its first month offering a "nanodegree" in Android programming, designed with Google, Udacity reported that students had submitted over 2,000 projects, which were then evaluated by a paid network of coding experts around the world. Cofounder Sebastian Thrun says 91 percent of paying students with this kind of coached model finish the course. Though it's not a perfect contrast, the free robotics MOOC Thrun taught as a Stanford professor had a completion rate of 2 percent.

The data from online instruction offers a new level of feedback for teachers, too. Teachers on the Coursera platform have a dashboard on which they can see exactly when in a video students are most likely to stop watching, what percentage of students are getting an assessment question right the first time, and other metrics. If only 20 of the 200 students taking a quiz got a certain question right, teachers can reëxamine how they taught that point in the video or how the question was worded to see what's going wrong.

"I taught in a university 18 years and I never got that kind of detailed feedback," says Daphne Koller, a Stanford engineering professor who cofounded Coursera three years ago. —*Nanette Byrnes*

THE CONNECTED CLASSROOM

Online learning comes into the classroom. By Kristin Majcher



DIGITAL DOCUMENTS New apps and software platforms allow teachers to keep their student lists, attendance records, calendars, and correspondence all in one place. Google Classroom is one that allows students to hand in homework online and see their grade when the teacher is done reviewing it. Schoology is another popular example.

COMMUNICATION More than 20 percent of U.S. teachers use an app called Remind to text parents and students about deadlines without exposing personal information, according to the app maker. Pearson's PowerTeacher and PowerSchool apps give parents real-time feedback about their children's grades or behavior.

CLASS WEBSITES Teachers can make class websites using Haiku Learning or Google Sites without writing code. Many schools now make announcements on Facebook and Twitter. Science teacher Jessica Anderson at Powell County High School in Deer Lodge, Montana, uses the @SciencePCHS tag on Instagram, Twitter, and Vine to post class projects like a Rube Goldberg machine.

GAMING Students can earn points for good behavior on ClassDojo, or by answering questions on their smartphones in the Kahoot app, which claims 30 million users. Students playing ClassCraft use special powers to advance their team through a virtual world. Correct answers unlock perks like the right to ask questions during tests.

STUDENT DEVICES More and more schools aim to have a laptop or tablet for every student. The 435 students at Intrinsic, a charter school in Chicago, had Chromebooks last year. Powell County High School distributed laptops to students three years ago, switched to iPads this year, and will issue HP Stream laptops next year.

PROJECTS Students can map out writing assignments on iPads through Inspiration and upload notes into Google Drive with Notability. Writing.com's Writing Prompts app gives students ideas for essays, and Scholastic's Book Wizard helps students and teachers keep track of interesting books they would like to read.

CLASSROOM DESIGN Intrinsic divides its English and math classrooms into different areas. Students learn directly from teachers in one section, have group discussions on blue chairs in an area called the "ocean," work independently on the "coastline" (which snakes around the room's perimeter), and work in groups at tables in the "shade."

STREAMLINED SECURITY Protecting and securing student data is a growing concern. Through Clever, teachers decide which education tools can access encrypted student data and how much they can see. Clever, Apple, Google, and AT&T are a few of the 150 technology companies pledging to protect student data from being sold or used for advertising.

LAURIE ROLLITT

Q&A

The Believer: Duke's Sally Kornbluth

Duke's provost says there's no question that students are getting value from online learning.

● Of all the U.S. universities offering free online courses to the world, Duke University in Durham, North Carolina, is among the most active. Its professors have filled Coursera's distance-learning platform with 30 courses, in subjects ranging from astronomy to dog emotions. Since 2013, the university has assigned one administrator exclusively to digital and online education initiatives. There's even a collection of sunny haikus about online education on Duke's website.

"A few years ago, the question was 'Should we be teaching online or shouldn't we?' says Duke provost Sally Kornbluth, a geneticist by training. "That conversation has passed. Now it's a conversation about what kinds of innovative things we can do." In a discussion with *MIT Technology Review* contributing editor George Anders, Kornbluth explained why Duke is bullish about online education—and what new opportunities lie ahead.

Universities have been relying on books, lectures, and seminars since the 1400s. Does online learning provide a fourth channel that can rival the others?
It's supplementary. It hasn't replaced in-person lectures or books. But there's no question that students are finding it another avenue for getting the information they want. Frequently, that's complementary to traditional settings. In other words, they're looking for more background. Online learning actually enriches their in-person experience.

Tell me more about blended learning—where instructors use a mix of online tools and classroom settings. How much is that happening at Duke, and what are the results?
We have a lot of "flipped classroom" education going on. It's not in every corner of the university, but you will see plenty of situations where students do online exercises or watch material online ahead of class. Then faculty can use class time for experiential learning or discussions, rather than straight-on delivery of didactic material. Students still get in-person interactions with fellow students and the faculty. We create touch points that interface with the technology, rather than having the technology be stand-alone.

Which specific techniques in online education strike you as game changers?
I'm really interested in the trend toward bite-sized pieces of education. The first MOOCs were replicas of the traditional, full-semester experience. Now, though, we're seeing professors offer 15-minute modules, or three-week pop-up courses. People are experimenting with a lot of formats that break with traditional content delivery. In fact, I caught my son taking online physics courses at Yale, watching them at double speed.

What's the impact of MOOCs on the way your professors do their jobs?
At Duke, it's revitalized the notion of pedagogic innovation, in a way that's spilled out of the online space and into the regular classroom. You can take your base course, add some content, and then retailor it for alumni education or executive education. You can interact directly with people all over the world to address a common issue. Or if you're wondering how you can possibly read 400,000 essays, you can have 400,000 students read one another's essays. There's a lot of unexplored power that can be harnessed.

What are some issues associated with online learning that you haven't solved?
One of the things we haven't grappled with is how online teaching factors into things like promotions and tenure. Right now it doesn't have a formal role; it's still just an add-on. And at the undergraduate level, we aren't offering stand-alone online courses for credit. That would be a much more serious conversation that would involve a lot of faculty discussion and approval. I really don't know the answer to that at this point.

When people apply to study at Duke, is MOOC completion a relevant factor yet, in terms of how the admissions office sizes up candidates?
It's really interesting. We aren't yet doing anything on an aggregate level. But we have been seeing home-schooled kids who took a couple of our classes online to see if they could do Duke-level work. Also, faculty who have been teaching MOOCs have reached out to their best students internationally and have encouraged them to come to Duke as graduate students. So MOOCs are entering the larger universe of recruiting modes for us.

How well can we gauge whether online students have mastered the material?
We have a pretty robust assessment process. We have staff dedicated to seeing whether students are really getting what we hope for out of the classes. I get the feeling it's going pretty well.

Online education providers are still working out their business models. What approaches seem wisest to you?
It's tough. A lot of the original motivation for MOOCs was altruistic—connecting worldwide with people who might not have access to a Duke-level education. I think a lot of faculty members are still really motivated by that. Being paid or for-profit takes that away. Charging for accreditation seems reasonable, but you almost have to have waivers equivalent to financial aid.

Have you tested out any MOOCs yourself, as a clandestine student?
I always wanted to take a good biostatistics class. I tried one, but then I realized that my college math skills had become so rusty that I would have needed to back up and do a more introductory course first. Right now, I just don't have the time. But when I retire, I'll take some.

Q&A

The Skeptic: Stanford's John Hennessy

Stanford's president questions whether online learning can match traditional instruction in motivating students.

● Stanford president John Hennessy has a background that would make it tempting to regard him as the online-education insurgents' best friend. He joined Stanford in 1977 as a professor of electrical engineering. He has founded his own computer company and continues a high-level involvement in Silicon Valley, where he serves as a Google director.

Hennessy turns out to be surprisingly cautious, though, about online education in general and massive open online courses (MOOCs) in particular. Traditional teaching has some hard-to-imitate strengths, he pointed out in an interview with *MIT Technology Review* contributing editor George Anders. Among them: classroom instructors' ability to inspire students and to gauge how well they have mastered the material.

How do you think online learning compares with traditional methods?
The advantage is the disadvantage. MOOCs let you reach a very large audience that's highly distributed in terms of its ability to master the material. That's an inherent property of a course that's meant to be massive and open. And therein lies the difficulty. If the students are all over the map, then a large fraction of them will feel everything is going too fast. Many will feel it's too slow. That's quite different from a traditional classroom at Stanford.

Two of the best-known MOOC platforms, Coursera and Udacity, were started by Stanford computer science professors in 2012. What advice did you give them?
I encouraged them to try, because I believed several things could only be learned by moving the technology out to the market quickly. First, what kind of investment would be necessary to create a high-quality platform. Second, where the market would emerge. Indeed, lots of the market turns out to involve professional training. That's outside the traditional space that universities serve. You can aim a company in that direction. It's harder for a university to move in a direction that's not coherent with its core goals and mission.

What's your perspective on blending online tools and face-to-face teaching? We're hearing a lot these days about the "flipped classroom," in which students listen to lectures online and then use class time for problem solving.
We need a lot more experiments. We need people to try out things and measure them. There's one really good experiment involving an online statistics class from Carnegie Mellon. It showed quite clearly that a flipped classroom can lead to comparable performance versus traditional instruction, in less time. If you could reduce the time that students need to learn the material—and be sure that students aren't learning less—then we would have something valuable.

Distance learning has been around for a long time. How have we moved beyond some very clunky beginnings?
Active learning. The truth is, looking at a talking video for an hour is absolutely no more motivating—perhaps even less motivating—than sitting in a large lecture hall for an hour. You need a more interactive experience that requires you to pay attention and answer a quiz before going on to the next section. That gives the students some confidence.

Professors at top-tier universities are ambitious souls. Has MOOC creation become a badge of glory in some disciplines?
For us, it's more about some contribution to the public good. I mean, there's some brand building going on, but it's mostly just a way of sharing content with people who wouldn't have access to it otherwise.

How could online learning methods become more useful?
We're trying to build analytics so that we can give feedback to faculty. In a traditional, large science or engineering class, you don't know until the midterm or the final whether there's some topic that's a disaster in terms of the students not getting it. Online, you can get feedback much sooner. You might even be able to get it before the lecture is over, so that you can fix it while the class is still going on. We'd like to fold that in, so that we can develop teaching that gets progressively better.

Can we gauge whether online students have truly mastered the material?
We're still stumbling around, finding the right mix of automated grading, peer grading, and some role for graduate students or other trained evaluators. There are just some things that can't be graded automatically. And in high-stakes situations, peer grading makes everybody nervous. Motivation and personal contact are critical issues. I just don't think that beaming a MOOC into somebody's bedroom is going to create the kind of engaging experience they're going to need to succeed in school. The technology will get better, but it will take some time.

How do you like what's in the marketplace now?
There are a wide variety of issues that have to be solved. For-profit or nonprofit; consortiums or institutions going in alone. Who actually does the instruction? Who provides the certification? They're still playing out in real time.

Did you ever try any MOOCs yourself, as a student?
I started this American poetry class from Penn. The material was well presented. For the self-motivated individual, this stuff works well. The MOOC creates a learning community that's really the modern version of a book club. I don't know how much you could charge for it—but it's an interesting learning environment.

Case Study

India Loves MOOCs

In a country of rigid teaching styles and scarce university slots, students and professors are exploring what online learning can be.

● How does a talented Indian teenager like Gaurav Goyal make his mark on the world? Ordinarily, his destiny would have been set on the morning in 2008 when he took his country's toughest college placement exam: the IIT Joint Entrance Exam. More than 300,000 students attempted the test that year; only 8,652 qualified for a spot at one of the ultra-elite Indian Institutes of Technology.

Goyal mustered a score in the top 1 percent, winning entry to IIT Delhi. But he fell just short of the cutoff for the school's most competitive degree program, the one he most wanted to pursue: computer science. Instead, Goyal was told to major in civil engineering. Other students could learn about databases. For him, hydrology awaited.

Determined to change his fate, Goyal, an extrovert with a keen interest in business, found a way to outwit the system. As he recently explained over a dinner of curried cottage-cheese skewers at a fancy lakeside restaurant in Delhi's Hauz Khas district, he wiggled his way into a variety of management courses at IIT Delhi and lined up his first job after graduation at Wipro, one of India's leading information-technology offshoring companies.

Then Goyal set out to sharpen his résumé. In early 2014, he enrolled in three online data-science classes via Coursera, all taught by Johns Hopkins professors. By earning certificates from the courses, demonstrating expertise in areas such as the programming tool R, Goyal impressed Dunnhumby, one of Britain's largest customer-analytics companies. He now works there as a Delhi-based senior analyst, using data to figure out what British shoppers want next.

Throughout India, online education is gaining favor as a career accelerator, particularly in technical fields. Indian enrollments account for about 8 percent of worldwide activity in Coursera and 12 percent in edX, the two leading providers of massive open online courses, or MOOCs. Only the United States' share is clearly higher; China's is roughly comparable. India's own top-tier technical universities have created free videotaped lectures of more than 700 courses, with the goal of putting students at regional colleges in digital contact with the country's most renowned professors.

In the United States and Europe, MOOCs have proved less revolutionary than their champions predicted when they launched on a wide scale in 2012. Rather than displacing traditional undergraduate programs, MOOCs in developed economies seem to find their biggest audience among those eager to learn more about history, psychology, or some other side interest. Those enrollees try lots of classes but often drop out after a few sessions.

12%
Proportion of edX students based in India.

It's a different story in India. There, online courses from the U.S. or Europe are finding a big following among college students and recent graduates, says Rick Levin, CEO of Coursera, which is based in Mountain View, California. They are a more serious bunch, hoping that the right technical courses can help them win better jobs. In a boon to Coursera's bottom line, emerging-market learners are also frequently willing to pay $29 to $250 for a certificate that attests to their successful performance on a final exam.

EVAH FAN

"I believe that India ultimately will be a much bigger market for MOOCs than the U.S.," says edX chief executive Anant Agarwal, who also is an MIT professor of electrical engineering and computer science. Indian students crave advanced knowledge that can open doors to a more prosperous life, Agarwal says: "If you've been trampled all your life, now you find you can stand shoulder to shoulder with the best."

Sheer demographics bolster his case: India's population of more than 1.2 billion is nearly four times the U.S. total. India's brightest students enjoy

the IIT campuses' cachet as the training ground of tech-sector leaders. A handful of other state-sponsored or private universities achieve top-tier status, too. By and large, though, a degree from most of India's 35,000 colleges simply doesn't register with international employers.

For aspiring Indian engineers and scientists, online credentials offer a way to stand out from the crowd. Coursera's most popular offering in India is an intensely practical University of Maryland course on how to build mobile applications for Android devices. After that come two Python programming classes from the University of Michigan and Rice University. Next is a Stanford class on machine learning. All told, eight of Coursera's top 10 courses in India are highly technical. (Even the two nontechnical classes on Coursera's leaderboard are designed for strivers: Learning How to Learn and Introduction to Public Speaking.)

Coursera executive Kabir Chadha is trying to persuade leading Indian tech employers to embrace his company's completion certificates as an important part of their job-candidate screening. Already, companies including Google, Wipro, Infosys, Infineon, and Microsoft have hired Indian engineers with online-education credentials, though such achievements don't yet factor into recruiting standards in a consistent way, if at all. Thousands of Indian engineers now list schools such as Stanford, MIT, and Carnegie Mellon as part of their educational background on LinkedIn, based solely on completion of online courses offered by professors at those U.S. universities.

Few people have wrestled more extensively with the challenge of teaching electrical engineering to undergraduates than Anant Agarwal. A product of IIT Madras and Stanford, he has been teaching at MIT since 1988, perfecting an upbeat, high-energy classroom style that has earned him two teaching awards. With his booming voice, untucked flannel shirts, and sweeping hand gestures, Agarwal projects a geeky charisma. One of his 2007 lectures has attracted some 550,000 page views on YouTube.

Given the opportunity four years ago to a create a globally appealing online course on circuits, Agarwal could have kept the star role for himself. Instead, he reworked camera angles so that he became an unseen background voice—while circuit diagrams and problems enjoyed full prominence. Online students needed to put each lecture's concepts to work, right away, by designing their own circuits and analyzing the ways that amplifiers, inductors, and other devices would operate. Built-in software allowed students' work on a digital sketch pad to be automatically graded within seconds.

It was a most un-Indian approach, sidestepping the long lectures, rote learning, and heavy emphasis on foundational principles that typify many Indian college courses. Indian campuses and tech companies began buzzing about this rare chance to experience hands-on teaching. Circuits 6.002x, as his MOOC was called, attracted 155,000 people worldwide in its 2012 debut—nearly 50,000 from India.

"I got super-excited at the prospect of being a virtual MIT student," Shreyas Jayaprakash recently recalled. He was finishing up his undergraduate studies at a regional college in Bengaluru at the time, worried that he couldn't compete successfully against other 6.002x students from around the world. But Jayaprakash raced to complete the course quizzes within hours after they were posted. He ended up with a 99 percent score on the final exam. Today he is a design engineer for the Bengaluru office of Avago Technologies, where he inspects chips that ultimately become part of Dell, Cisco, or Facebook servers.

Taking 6.002x "improved my problem solving," says Ashwith Rego, who is pursuing a master's degree in electrical engineering from IIT Bombay. One quiz gave Rego a better understanding of oscilloscopes. Another had him analyze car suspension systems. On the hardest problems, he tapped into online discussion forums, populated by students from as far away as Argentina and Ukraine.

What Agarwal started, dozens of other U.S. professors have now exported to India, too. Jim Fowler, an assistant professor of mathematics at Ohio State, teaches Coursera's most popular online calculus class. Instead of lecturing nonstop at a whiteboard, he pauses periodically to blow up a balloon or cast shadows with a stick-figure puppet—helping learners visualize the integrals and derivatives they are being asked to calculate.

Such showmanship delighted Surya Prakash in 2013, when the West Bengal student took Fowler's calculus MOOC. Prakash had finished high school and was trying to score well enough on the Joint Entrance Exam to win admission to an elite engineering college. Earlier attempts to master calculus had gone badly, but Prakash seized on Fowler's examples and drew on them to achieve a strong test score—and a ticket to a first-tier college in Jaipur.

Mixing facts and fun in a MOOC "helps you remember things better when it comes time to take the exam," says Mahesh Kumar Hiremath, a computer science major in his senior year at BMS College of Engineering in Bengaluru, who has taken at least eight MOOCs, often to get a second perspective on his actual courses in topics such as algorithms or Java. The extra effort has paid off; Hiremath has earned As in most of his classes and is joining SAP after graduation.

In India online courses are finding a big following among college students and recent graduates, hoping that the right technical courses can help them win better jobs.

BMS's snug urban campus is a sanctuary from the noisy motorbike traffic of modern-day Bengaluru, and a contrast to the opulent 16th-century temple to the Hindi demigod Nanda that sits just across the main access road. The school attracts people with a single-minded focus on academics, many the children of middle-class accountants, engineers, and biologists.

"There are a *lot* of computer science engineers in my family," Chaitra Chandrasekhar, who's majoring in medical electronics and biomedical engineering at BMS, wryly observed, during a roundtable chat over tea and biscuits at the school. Like many of her peers, she has used online classes as a safe, easy way of expanding her horizons, even if some explorations (such as a short-lived attempt to learn German) went nowhere. Medha S. Bharadwaj, a medical electronics major, took a Python programming class to help her on the job market and a Western music class for fun.

Indian technical colleges seldom offer the wide-ranging electives that can be found on U.S. campuses. So BMS students such as Sharath Chandra tend to chuckle when they admit to signing up for online oddities such as a sports management MOOC taught by the University of Pennsylvania. It's irrelevant to his computer science studies, Chandra conceded. Even so, he added, "it was fascinating to find out how Real Madrid can sign a player for $80 million, and make back $40 million of that with extra T-shirt sales."

India's vast size and rapid development mean there is always a shortage of professors. With a record 3.2 million students currently enrolled in university-level engineering programs, there aren't enough experts to teach everyone in person. Essential courses can't be offered at all in some rural colleges; elsewhere, people with just a bachelor's degree are pressed into duty as instructors for first-year courses. The best hope of fixing this predicament, says pioneering Indian computer science professor Deepak Phatak, is a much bolder role for online education.

Phatak is India's most persistent champion of tech-based ways to stretch the classroom. In 2002, he and a colleague arranged for his IIT Bombay class in information science to be live-streamed, via video, to other Indian colleges. He is an active supporter of a national program that has made stored videos of elite institutions' course lectures available free of charge to anyone who wants to watch. Recently, Phatak and three other IIT Bombay instructors teamed up with edX to offer their own online introductory course on computer programming.

Making the technology hum is the easy part, Phatak says. It's harder to rearrange university priorities so that India's best instructors can be granted enough discretionary time to build first-rate MOOCs from scratch. Another barrier, Phatak says, is schools' reluctance to provide academic credit for online learning. He has been working with the All India Council for Technical Education to establish new guidelines that would allow students to earn 15 percent of their credits online. One proposal would let outlying colleges use a blended model, in which online instruction supplements class lectures and discussions. That approach will be put into action in the 2015–16 academic years, with about 50 of India's autonomous institutes working with IIT Bombay to offer blended MOOCs in three subjects.

"Every course can't be in the [U.S.-style] interactive format. Some have to be very serious lectures."

Eager to establish that India can create its own advanced online classes rather than importing content from the United States, the Ministry of Human Resources Development last year sketched out plans for its own MOOC platform known as Swayam. As of this June, however, only three Swayam courses had been announced. Coursera and edX each offer more than 500 online classes.

While Indian students are embracing the visual thrills and incessant mini-quizzes of U.S.-style MOOCs, their professors aren't as delighted. In 2012, Gautam Shroff, an adjunct professor at IIT Delhi, decided to create a Coursera MOOC on Web intelligence and big data. He came away with mixed impressions. Reaching a big audience was enticing, he observed, but "the average learner was nowhere near as well prepared as a typical IIT undergraduate." That forced him to teach at a more rudimentary level than he might have wanted, even though a few students were so savvy that they almost didn't need the course at all.

Shroff also found that in his field, it was hard to test the depth of students' understanding. The MOOC format required him to come up with assignments and exams that could be machine-graded, which tilted everything toward more superficial questions than might be posed in a traditional, hand-graded classroom exam.

Overall, he concluded, MOOC students are more likely to end up with an "awareness" of a field, rather than deep knowledge. That's not all bad, he observed. It just means that, at least for him, teaching a MOOC is "more like writing a short book than teaching a course."

R. K. Shevgaonkar, former director of IIT Delhi, has been testing various online education methods for at least a decade. He is confident that digital learning in some form is "a good solution" for India as it seeks to spread technical knowledge fast enough to satisfy the demands of a big, rapidly growing nation. He is eager to see India become an exporter of online academic instruction rather than a net importer from the United States.

3.2 million

Number of Indian students enrolled in university-level engineering programs

Shevgaonkar himself has posted on YouTube a massive, 60-lecture series about transmission lines and electromagnetic waves. This 2007 presentation lacks interactive quizzes or video-editing fanfare, but Shevgaonkar makes no apologies for the spartan delivery. His opening lecture has attracted a very robust 285,000 views, and a respectable 8,800 students made it to the final (60th) lecture.

"Every course can't be in the [U.S.-style] interactive format," Shevgaonkar argues. "Some have to be very serious lectures." —*George Anders*

Case Study

China's Startup Boom in Online Learning

Will a surge in distance learning for traditional subjects, test prep, language, and trade skills leave the poorest out?

● China knows a thing or two about distance learning. For two decades, the country's education ministry has used the television airwaves to broadcast agricultural lessons to more than 100 million rural students—making it the largest such program in the world. And in the early 2000s, the charitable Li Ka Shing Foundation installed satellite dishes and computers to broadcast lectures to 10,000 rural schools. Now this top-down model of online learning is being joined by a surge in new commercial and university offerings.

And it's no longer just about reaching rural provinces. In China a rapidly rising middle class—part of a population that now totals 1.4 billion—is creating a demand for education far outpacing what traditional teachers and schools can supply. In response, Chinese startups are identifying market niches and developing entirely new products, while universities are emulating online platforms first developed in the United States.

The trend is strikingly on display in Beijing's technology district, Zhongguancun, often called China's Silicon Valley, where a building housing 15 education-technology startups has become known as the MOOC Times Building. (The acronym formally means "massive open online course," but in China "MOOC" is used to describe any kind of online educational offering.) The startup community around Zhongguancun includes Hujiang, which has 80 million registered users, including three million who pay fees. Many are cramming for tests like the "gaokao," China's main college entrance exam. A startup called Jikexueyuan created a platform offering tutorials on programming and Web design that has signed up more than 800,000 users. And the newest entrants are more diverse platforms such as the parental-advice site Babytree. (Just enter Mom's due date and "you can get for you and your baby a tailored parenting guide," the site says, in Chinese.)

Chinese investment in education technologies has climbed from $137 million (in U.S. dollars) in 2013 to more than $1 billion in 2014, according to TAL Education Group, a publicly traded Chinese education firm based in Beijing.

And the startups in Zhongguancun are joined by a wide range of university and private entrants. Xuetang, a MOOC supported by Tsinghua University, for example, offers some courses on edX, an online platform sponsored by MIT and Harvard University.

In China, a rapidly rising middle class—part of a population that now totals 1.4 billion—is creating a demand for educational offerings far outpacing what traditional teachers and schools can supply.

Homegrown Chinese platforms for university education are emerging, too. One-Man University—founded by a former physics student at Peking University—has started distributing instructional 15-minute videos prepared by teachers to its more than 130,000 registered members through 56.com, a video-streaming website.

"There is a tremendous demand in China to get a U.S.-quality education," says Bryan Stolle, a general partner at Mohr Davidow, a venture capital firm in Menlo Park, California, that is funding Hotchalk, a company in Campbell, California, that's attempting to give U.S. universities a digital presence in China. Each year 750,000 Chinese students apply for college in the United States, and fewer than 200,000 are accepted, he says.

There are some concerns accompanying this trend. Although China has by far the world's largest number of Internet users, with more than 640 million people online, Internet penetration is only about 46 percent, compared with 87 percent in the United States. And a number of studies suggest that the benefits of online education accrue mostly to the already advantaged. Justin Reich, executive director of the PK12 Initiative at MIT and a research scientist in MIT's Office of Digital Learning, who recently spent time touring startups at the MOOC Times Building and talking to educators in China, says he also heard concerns about students becoming isolated and losing out on useful peer pressure, but that he generally encountered great enthusiasm.

$1 billion
Chinese investment in education technologies in 2014

"In China, all of these concerns are voiced against the backdrop of a much larger concern that there is a tremendous unmet demand for education," he says.

Online courses can in some cases not only fill a brick-and-mortar void but actually do a better job at teaching certain specific skills, says Rong Wang, a professor at Peking University who researches education finance. Traditional schools are very exam-oriented, "and many teachers don't have adequate capacities in delivering practical skills instruction to students," she says. And working adults aren't being served by traditional schools, which generally have only limited classes on evenings and weekends, she says.

Reich adds that there has been some discussion within the government of defining a set of requirements for degrees and then letting students meet some of them through MOOCs. If the government were to allow MOOC credits to apply toward a degree, he points out, such a scheme could rapidly be implemented nationwide. *—David Talbot*

Case Study

Lessons Learned

After a disastrous technology rollout in Los Angeles, schools reassess their priorities.

● In schools across the United States, chalk and textbooks are disappearing. In their place are tablets and laptops. This technological transformation is only just beginning, but it stands to reshape the ways teachers teach and students learn. In 2015, school systems will spend an estimated $522 million on tablets and readers, and $4.7 billion on IT overall. "Districts are trying to be very, very thoughtful about how they do this," says Scott Himelstein, executive director of the University of San Diego's Institute for Entrepreneurship in Education. "Obviously they don't want to be in a situation like LAUSD."

In 2015, school systems will spend an estimated $522 million on tablets and readers, and $4.7 billion on IT overall. For them, the Los Angeles iPad program is a cautionary tale.

He's referring to the Los Angeles Unified School District, the second-largest in the country, which in the fall of 2013 launched an ambitious plan to put iPads into the hands of each of its 643,000 K–12 students. But almost as quickly as the first devices were distributed, the plan imploded—a victim of incomplete software packages, easily circumvented security systems, and revelations that the supposedly open bidding process for the $1.3 billion contract was basically decided in advance.

In its rush to get its iPad program started, the district was handing out devices to students before the educational software was ready to be used, and without a clear strategy for integrating them into the classroom. The superintendent resigned a year later, and the whole deal is now the subject of a federal investigation.

LAUSD's blunder, which set a new standard for how not to go digital, teaches an important lesson, say experts in education and technology: school districts should be spending at least as much time figuring out how their classrooms will use technology as they do shopping for it.

L.A. wasn't the first school district to begin this digital transition. Public and private school systems in Baltimore, San Francisco, Boston, and many other cities have been augmenting their classrooms with technology for years. In 2002, the state of Maine began a program that would eventually outfit every one of its middle school and high school students with their own laptops.

While school systems are eager to jump in, the research on how technology can improve student learning is still relatively thin. Still, some early studies do find evidence that it can lead to measurable improvements, particularly through the personalized learning made possible by technologies and software that allow students to learn at their own pace.

A November 2014 report from the Bill and Melinda Gates Foundation on personalized learning practices found that the 23 schools studied showed gains in math and reading test scores significantly greater than those seen in a control group of schools without personalized learning. And a 2010 study of nearly 1,000 schools by the education research group Project RED found that classes with deeply integrated technology showed an increase in high-stakes test scores and a reduction in disciplinary action and dropouts compared with traditional classes. In terms of the actual technologies used, experts say tablets are proving especially effective at improving reading skills, while laptops help writing and research skills.

The research hasn't kept pace, however, with how quickly educational technology is evolving and being implemented in schools, says Sara Schapiro, a director at Digital Promise, an independent nonprofit authorized by Congress in 2008 that's focused on improving education through technology.

That's created a somewhat awkward situation for school districts. They're already full of what Himelstein calls digital-native students who've proved they can benefit from technology, but the school districts have little data to show taxpayers that investing millions or even billions of public dollars in technology will explicitly raise test scores or usher underperforming kids toward college.

$1.3 billion
Value of the Los Angeles Unified School District iPad contract

The case is particularly difficult to make in public school systems with diverse socioeconomic conditions and large student populations. "Laptops make a good school better, but they don't make a bad school good," says Mark Warschauer. He's a professor at the UC Irvine School of Education who's studied the implementation of technology in school systems, and he says it can't be the ultimate solution for schools with greater systemic issues like high teacher turnover. "That doesn't mean you shouldn't put computers into low-performing schools," he says, "but be realistic about the expectations and give the other kinds of broader support needed."

Broader support, many experts agree, begins with training teachers to use technology in the classroom. The newest gadget with the slickest software won't do much to help struggling students if their teachers don't understand how to integrate it into the curriculum.

Teacher training has been the priority at the Houston Independent School District, which is currently phasing in a program that would provide each of the roughly 46,000 students in its 40 high schools with a laptop. Lenny Schad, the district's chief technology information officer, says it's a multi-year initiative in each school that starts with training

principals and teachers to integrate the technology into their curricula and only gradually increases the school's reliance on it. "The focus has very little to do with technology. The focus is on 'What are we going to do to facilitate changing instruction?'" explains Schad.

Some smaller, more nimble districts are moving faster. Just north of San Diego, the 5,500-student, K–6 Encinitas Union School District began planning its digital transition in 2009 with a goal of increasing individualized learning. After some early pilot tests in single classes, the district implemented a program for the 2011–12 school year that provided each child with an iPad. Tim Baird, the district's superintendent, says students have shown marked improvements in learning the state-required curriculum after using game-based apps like ST Math, and they have also made more creative uses of the iPad's apps—for example, using iMovie to integrate filmmaking into class projects. A short documentary produced by a group of elementary school students recently won an award at the California Student Media Festival. Baird says surveys of students, teachers, and parents show that student engagement is way up since the iPads were introduced.

"I think sometimes you've got to go slow to figure it out and then sometimes you've got to go fast," he says. "This could have been a 10-year implementation, but look how much learning would have been lost in that time."

In the wake of its iPad fiasco, however, LAUSD—more than 10 times the size of Encinitas USD—is slowing things down. The new superintendent, Ramon C. Cortines, recently launched a task force of teachers, administrators, and education experts to draft a strategy for implementing technology throughout the district.

Recently, about 40 task force members gathered in a basement classroom at an L.A. high school to hear from a few LAUSD principals. After their presentations, Judy Burton, the founder of a public charter school system and the task force's volunteer chairperson, told the principals to imagine they had a "magic wand" and could outline a technology implementation plan for the entire district. "What would you want that memo to say?" she asked. After a beat of silence, the room broke into laughter. In a district with more than 643,000 students spread across more than 1,000 schools, the prospect of crafting a single approach is daunting. "Lessons learned," Burton says of the bungled iPad program: "there are no quick fixes."

The task force will present its recommendations to the LAUSD board in November. *—Nate Berg*

Industry

Hacking Diversity

Open-access instruction, online and in person, has introduced coding to new students and created welcoming communities for people traditionally underrepresented in technology.

● Anyone with Internet access and a computer can learn how to write a few lines of code these days. Free tutorials and information from sites like Codecademy, which has been used by more than 25 million people, offer widespread access to instruction. They might even be able to break down barriers for groups traditionally underrepresented in technology, including women, blacks, and Hispanics.

This open-access model does seem to help—Codecademy says 34 percent of its users are women, for example, nearly double the percentage of female graduates from university computer science programs in the United States.

It's not uncommon for women to use free programs as a starting point and then seek out women-only groups in their community. One such program is the Women's Coding Collective, started in 2011 as a Meetup group in Boston by two women who wanted to collaborate on an app and decided to host events to bring together a broader network. Now the group hosts Web development classes that cost $25. Since its first picnic meetings, the collective has hosted 130 events and grown to 6,000 members from all over the world who take classes in Cambridge, Massachusetts, and online as well as attending events and workshops.

San Francisco's CODE2040, started three years ago, focuses on teaching professional and entrepreneurial skills to blacks and Latinos. Even though 18 percent of U.S. computer science degrees are awarded to members of these groups, their representation in the tech workforce is just over half that level, according to 2012 and 2013 data cited by CODE2040 and the Level Playing Field Institute. At Google, only 2 percent of employees are black and 3 percent are Hispanic. The company just awarded CODE2040 $775,000 in grants to finance new workshops, retreats, and an online platform to help coders and entrepreneurs apply for jobs and expand their businesses.

Shannon Turner, a Web developer, got the idea to start women-only classes when she found herself outnumbered by men at tech events and not always taken seriously. She started Hear Me Code in September 2013 to teach the Python programming language to a handful of women at her kitchen table in Washington, D.C. Since then, the program has grown to 1,200 women who signed up to take four-hour weekend classes every few weeks and meet at informal groups during the week to hone their skills.

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Students practice Python for several months, and Turner puts in 40-hour

weeks developing the curriculum, mentoring students, planning the logistics for classes, and approving new members, all in addition to her day job as a freelance Web developer. The classes are free, and the group sustains its growth with volunteers. More than 50 students who took the class have now signed up to teach others.

To Turner, the problem with some online coding courses is that they don't make the content relevant. Her curriculum allows students to write programs for tasks that seem useful, especially to the D.C. crowd. In one of the first lessons, students learn to make a drop-down menu of 50 states that can be used to help organizations make online forms for new members. In another, students write a program that scans two lists of e-mail addresses to pinpoint people who attended both a film screening and a happy hour.

One of the most successful aspects of the program is the way it builds a community of women who learn new skills and then pass them on by teaching in the program or organizing other tech events. Many students participate out of personal interest or to help with their current work, but the classes have even helped some women get new jobs using their coding skills. At least a dozen women have gotten jobs as developers since they took the free Hear Me Code class, for example. One is Sonia Hinson, who initially used Python to coördinate the efforts of her employer, a humanitarian aid organization, to send aid to hospitals. Hinson recently took a new job at a tech company.

—Kristin Majcher

TECH FOR TEACHERS

Our list of some of the most interesting offerings in the booming online education market. By Kristin Majcher

	Description	Interesting Fact	Funding
CLASSDOJO	Mobile app allows teachers to award points to students when they participate or do well in class, and to send reports about students' behavior to parents.	More than 35 million teachers, parents, and students use ClassDojo in 50 percent of U.S. schools.	More than $10 million in funding from Felicis Ventures, General Catalyst Partners, and others.
CODE SCHOOL	Learn-to-code class from Pluralsight, which offers online IT and Web development classes. Students earn badges as they complete more than 40 classes. Rivals include Treehouse and the free Codecademy.	More than a million people have signed up for Code School classes.	Acquired by Pluralsight in January for $36 million.
DREAMBOX LEARNING	Provides math curriculum tailored to individual elementary and middle school students using online software. Has started offering the math curriculum in Spanish. Usage has doubled each year since launch.	Delivers a million individualized math lessons per day.	Has raised $14.5 million in funding, led by Netflix CEO Reed Hastings.
DUOLINGO	Turns language learning into a game on its colorful free website and app. More than 90 million users have signed up, 15 to 20 million of whom are active monthly users.	A 2012 study found studying on Duolingo for 34 hours as effective as a semester-long college class.	Valued at $470 million after a recent $45 million investment from Google Capital and others.
KHAN ACADEMY	Offers more than 2,400 free video lessons for everyone from kindergartners to people well beyond high school on topics including math, science, economics, and computing.	Students have accessed more than 440 million lessons and finished more than three billion problems.	Nonprofit funded by donations from the Bill and Melinda Gates Foundation and others.
KNEWTON	Provides online educators with recommendations about what individual students should study by measuring data like how long students took to answer a multiple-choice question.	Has given more than 15 billion recommendations to more than nine million students since 2008.	Raised $105 million in venture funding from First Round, Pearson Education, and others.
LYNDA.COM	Helps professionals learn new skills in technology and business. Monthly subscribers can access a library of video lessons with more than 3,500 courses and more than 144,000 videos.	Customers include state governments, top ad agencies, the U.S. military, Fortune 50 companies.	Acquired by LinkedIn in April for an estimated $1.5 billion.
PEARSON	Provides online curriculum and tools for teachers and students in K–12 and higher education. More than half a million teachers have used its classroom management system to track attendance and grading.	Its software was part of the unsuccessful L.A. Unified School District digital initiative.	Public company with 4.9 billion British pounds ($7.6 billion) in sales in 2014.
UDACITY	Partners with tech companies like Google, Facebook, and AT&T to create online video courses in subjects including Web development and data analysis. For a fee, students can earn a "nanodegree."	AT&T reserved 100 paid internships for the top-performing students who finish the programs.	Raised $58 million from firms like Andreessen Horowitz and Charles River Ventures.
UDEMY	Provides more than 30,000 online courses in areas like computer programming, languages, music, photography, and personal development to more than seven million students.	It would take more than 6.5 million minutes to watch all of the Udemy course videos.	Raised $113 million from Stripes Group, Norwest Venture Partners, and others.

Q&A

Uber for Education

Sebastian Thrun, a leading figure in artificial intelligence, hopes his startup Udacity will be a digital university for a new kind of economy.

● In 2012, Sebastian Thrun, an expert in automation and artificial intelligence and a former tenured professor at Stanford University, became the cofounder and CEO of Udacity. There he is creating a rival to traditional postsecondary education: a university focused on lifelong learning, in very small portion sizes, on demand and in a mobile format.

Udacity's recently announced "Android nanodegree" was created with a $4 million investment from Google. It's a six-to-nine-month program costing students $200 a month and promising to teach them everything about programming for Android, from the fundamentals to building apps. Projects are graded by Udacity's network of 300 global code reviewers. As he explains to Business Reports senior editor Nanette Byrnes, those contractors are a key part of Thrun's current vision for Udacity—a departure from the more common MOOC (massive open online course) model that the company initially seemed to be following, in which professors lecture and students do problems independently online.

$17,000
Monthly earnings of Udacity's top global code reviewers

Teaching students to master a topic, difficult in any classroom, seems to be one of the biggest challenges facing online learning. You say your approach works. How does it?
We very deeply believe, very passionately believe, that learning by doing trumps learning by listening. We believe the ultimate experience that really makes the master is to do something, build something, invent something, design something, code something. At Udacity, we built an Uber-like platform. With Uber any normal person with a car can become a driver, and with Udacity now every person with a computer can become a global code reviewer. And the mechanics for the code reviewer are the same: you're being paid per code review, and you're being assessed by your students. Our global code reviewers, on average, out of a five-point possible score, get 4.8 points. They give students back a very insightful and detailed, human-level, expert-level review of their work, typically within two hours, including detailed feedback on coding style, what works, what doesn't work, and so on. Just like Uber, we've made the financials line up. The best-earning global code reviewer makes more than 17,000 bucks a month. I compare this to the typical part-time teacher in the U.S. who teaches at a college—they make about $2,000 a month.

Universities have become more and more exclusive ... Industry says the opposite: make it as cheap as possible so we can reach everybody.

Is this particularly applicable to teaching coding? Can this translate to other fields as effectively?
I want to be careful not to say every field, but in many, many fields, you learn by doing and not by listening. Fields we are not going to engage in would be something like tennis or violin, where your own practice is absolutely fundamental. But in all my life, honestly—be it math, be it finance; I've done some medical studies, I recently became a pilot and learned to pilot a plane—in all these studies the mechanism is quite similar: the most effective learning environment is often one where the student gets to practice something under the guidance of someone more experienced and then gets personalized feedback on how they are performing.

This is a digital way, I guess, of re-creating that mentoring or coaching that a student can have with a teacher.
Our data shows that having this dedicated human touch leads to much more profound learning effects. We couldn't really do this with computers because they are not smart enough yet. You not only have someone to go to when you need help but also someone to hold you accountable, too, and that has a big impact on learning.

You told me these reviewers could be in the U.S., India, Canada, anywhere.
With Uber you have to be in the same city to drive a person around in your car. With Udacity you can be in Chile and grade someone's work in Lebanon, and the person in Lebanon wouldn't even know the grader happens to be in Chile. The grader's ability to stay in the network to make money is directly contingent on student love. So he or she is going to work really, really hard to make their review extremely insightful. The student wants an insightful review; they pay us money to get the most insightful reviews. By giving them the power to review the grader, all the incentives line up.

You've spoken often about your desire to democratize education, to reach a broad audience and reach people who don't have access to this kind of education otherwise, but Udacity is a business. You charge for your classes while many MOOCs are free.
Education should cost money because of the service rendered. So we decided to have two paths. Access to our content basically costs us nothing—it costs us like 50 cents a student, and we decided to just give this away. If you are in central Africa and you really want to get an education, anything that is easily replicable for us

we give to you for free. The reason why we can do this without going bankrupt is this kind of freemium business.

You have a successful partnership with the Georgia Institute of Technology, but some of your university tie-ups did not work out, and now you are only adding new programs developed with private industry. Why do you think you couldn't succeed with universities?

We chose to go to industry because we believe the future of learning is lifelong and not just one-time. We have data from the Department of Labor Statistics that says the average employment in a job in 2002 was 4.6 years. We know that is shrinking. We know people have seven different careers over their lifetime. As a result, we needed to do two things: make the learning unit smaller than the conventional degree and make it fresher than a traditional degree. At the end of the Google Android nanodegree, we are teaching features of Android that you can't find anywhere else, that just launched in Android. Google is now running a career summit where they are inviting the top students from the Android nanodegree on campus, all expenses paid, to meet with their engineers and their recruiters. We are effectively building an alternative path to employment and an alternative to existing credentials.

Colleges are very focused on the ages from 17 to maybe 24, but people live 70 to 80 years now in many countries. For people in their 30s, their 40s, military people coming back [to civilian work], women raising children who want to reënter the workforce, all huge factors in the workforce—for those people there's no educational venues that I know of that work in this country. There's a huge vacuum.

Universities have become more and more exclusive. In fact, they pride themselves on their exclusivity in admissions, and as a result they attract the best professors because they want to work with the best students. There's a network effect that only works with exclusivity. Industry says the opposite: make it as cheap as possible so we can reach everybody. I think it's a much better alignment.

Technology

Getting Fluent

Can an algorithm teach us language?

● Since it launched in 2012, Duolingo has been studying every move made by the 15 million–plus people who use its website and mobile app every month to study foreign languages. The company is run by technologists—it hired its first learning expert this year—and constantly tests different ideas, looking for trends in the data.

Its current goal: helping students become fluent.

As measured by the Common European Framework of Reference for Languages, Duolingo can at present get students, at best, to the point where they can express themselves in familiar situations, or the B1 level. Full mastery is three levels higher, at C2.

No software has yet been able to get students to fluency, but Duolingo believes it can achieve this goal by hiring more learning experts and studying the data, says cofounder Severin Hacker. Its language lessons are free, but the company earns money by selling $20 certificates attesting to student performance on a 20-minute English test, the results of which it says correlate with those of more established, and expensive, options including the Test of English as a Foreign Language, or TOEFL. Duolingo has raised $83 million in financing from Google Capital, Union Square Ventures, Kleiner Perkins Caufield & Byers, and others.

The company has already drawn from its constant experimentation to change many features and create new ones. A team of machine-learning specialists is fine-tuning the way its algorithm determines what students know, what they should study next, and what messages best motivate them to keep learning, delivering an adaptable, personalized learning experience.

Duolingo feels more like a game than like traditional language learning. Originally it would award students three hearts at the start of a 20-exercise lesson. Every mistake cost the user one heart. Lose all three, and you had to repeat the section.

After experimenting with three, four, and five hearts, Duolingo determined that four was the best motivator for new students. More advanced students did best with three and would still see that number. Since those experiments, the company has introduced a more sophisticated strength bar that takes into account nuances such as the relative importance of different issues. For example, it incorporates the idea that getting the gender of a word right is not as important as getting the word itself correct.

$83 million
Venture funding raised by Duolingo to date

A year ago Duolingo began another experiment with a digital coach, an owl avatar that tracks goals students set for themselves and then tells them if they fall off track.

"It's thousands of little experiments we run," Hacker says. "Some are really good, but really it's the combination of thousands of things that makes the difference." The average time a student continues using Duolingo has more than doubled since its launch, says Hacker.

Greg Smolinski, a teacher who incorporates Duolingo into introductory German classes for seventh and eighth graders at Seneca Valley Middle School in Pennsylvania, says some of his most motivated students have gotten to the B1 level using the program on their own, effectively replacing hundreds of hours of

What People Study on Duolingo

Duolingo's top markets:

1. **United States**: English speakers studying various foreign languages
2. **Brazil**: Portuguese speakers studying English
3. **Mexico**: Spanish speakers studying English
4. **China**: Chinese speakers studying English
5. **Colombia**: Spanish speakers studying English

classroom time with work done independently and online.

Language experts are not sold on the idea that a program like Duolingo can get a student to fluency. "I do not think that a language platform can replicate the face-to-face communicative interaction that is so important in language learning," says Véronique Baloup-Kovalenko, who teaches French at the Convent of the Sacred Heart in Greenwich, Connecticut. Nonetheless, Baloup-Kovalenko appreciates Duolingo's ability to tap into students' competitive spirit and sustain their interest. The company quotes her praise on its pages for educators. *—Nanette Byrnes*

Technology

Educational Technology Faces a Pivotal Privacy Moment

Student performance data can hold valuable insights for educators developing personalized learning programs, but some highly restrictive laws threaten to deprive students of the potential benefits.

● Mark Pickard's in-box is full of pitches from software companies. "I bet I get two or three e-mails a day from somebody trying to get us to use their new platform or whatever it is they have," says Pickard, an eighth-grade science teacher who works in Malden, Missouri.

Though Pickard's been getting such solicitations for years, there's something different about the recent batch. They still promise to provide personalized experiences for students based on information a company collects—for example, by recognizing specific problem areas or particular types of learning styles and then creating learning plans tailored to individual profiles. What's changed is how the companies treat that data once they have it: whereas a few years ago it was obvious that many of them were planning to sell the data, now most make absolutely clear that they will not do that.

The reason can be found in a recent explosion in state legislation regulating the use of student data and safeguarding its privacy and security. Responding to growing parental fears that hackers will steal their children's personally identifiable information, or that companies will sell such data or use it to target advertising to kids, legislators in 30 states have passed laws dealing with the issue since the beginning of 2014. They either spell out procedures for collecting, storing, and using student data or prohibit the gathering of certain types of sensitive data, like information related to health, religion, or political affiliations.

Responding to growing parental fears, legislators in 30 states have passed data privacy laws.

Still, parents remain worried, and their concerns are not unfounded. Last year Google admitted to scanning the e-mail of students using its Apps for Education software, gathering data that could have been used to target ads at those students. (The company said in a subsequent blog post that it had discontinued the practice.)

Online service providers like Google are not explicitly regulated under the 40-year-old Family Educational Rights and Privacy Act, which safeguards the privacy of student records. Many argue that the law should be updated to reflect the new class of educational software makers vying for a piece of the estimated $8 billion market for such products. But although President Obama has called student data privacy a priority, federal progress has been slow, and states are filling the void.

Without some clear guidelines, the risk is that more education technology providers could go the way of InBloom. A nonprofit data management and storage company launched in 2013, InBloom closed its doors last year under pressure from fearful parents after activist groups cast the company, which had been backed by the Gates Foundation, as a shady group looking to profit from student data.

Defenders say InBloom was not doing that at all. But the backlash against the company is seen as one of the major factors setting off the flurry of legislative activity by the states. California led the way: last fall it enacted a law that clearly restricts companies from selling student data or using it for targeted advertising.

The danger is that parents' fears, which often stem from a lack of information about how and why student data is collected and used, could lead to restrictive policies that stifle innovation, says Rob Curtin, a Microsoft veteran who is now the chief privacy officer at the Boston-based startup Pip Learning Technologies. Curtin has a reason to care: his company is building a service that would securely and privately connect educational institutions and those who would like access to student data, including parents and technology companies.

"There are a ton of positive outcomes that can come from sharing data," says Curtin. Insights drawn from data like multi-year sets of student assessments and tests, for example, could be used to help educators tailor instruction to individual students, he says, while overly restrictive policies could prevent that by closing off opportunities to share such data. Curtin also sees value in enabling parents, who spend billions every year on supplementary education, to securely share their child's school data with outside specialists to create tailored instruction. Most of all, he says, parents need to know what is happening to the data and how it is being used.

"There is a right way and a wrong way to do this," says Curtin. "And if we follow the rules, we *can* move data around, and there are really good reasons for doing that." *—Mike Orcutt*

Most Popular MOOCs

The number of massive open online courses (MOOCs) is growing by the day. Here are some of the most popular courses.

edX

About: With more than 70 institutions including MIT, Harvard, and the University of California, Berkeley, contributing classes and 4.5 million students who've registered an account, edX is one of the best-known providers of MOOCs, offering more than 500 courses in all. Completion rates range from 5 to 7 percent but rise to 60 to 80 percent for students who purchase verified certificates of completion at a cost of $25 to $99, depending on the course.

Most popular course: HarvardX: CS50x—Introduction to Computer Science

More than 420,000 students are enrolled in Harvard University's self-paced, entry-level computer science class, taught by David Malan. They complete nine problem sets, which take from 10 to 20 hours each, and complete a final project.

Canvas Network

About: Canvas Network offers more than 300 courses from 160 institutions. As of June, it had 68,800 students actively taking 66 classes, with another 20 about to start.

Most popular course: Society, Science, Survival: Lessons from AMC's *The Walking Dead*

Of the 65,562 students who enrolled in this eight-week class sponsored by the University of California, Irvine, 3,783 finished. Professors Zuzana Bic, Michael Denin, Sarah Eichhorn, and Joanne Christopherson schooled students on everything from Maslow's hierarchy of needs to how infectious diseases spread to the prospects for nutrition in a post-apocalyptic world.

Coursera

About: Coursera offers more than 1,000 free classes from 122 institutions and boasts more than 13.7 million student accounts; it's achieved broad popularity across the globe. The classes are free, but students can opt to receive a certificate for a fee that varies depending on the course.

Most popular course: Learning How to Learn: Powerful Mental Tools to Help You Master Tough Subjects

Offered through the University of California, San Diego, the class attracted 535,498 active learners in the past year. Students watch four hours of video about how to effectively learn new subjects and complete three hours of exercises. Then they can opt to complete another three hours of bonus material. The full course is available in English and Portuguese, and video subtitles are also offered in Spanish and Ukrainian.

FutureLearn

About: FutureLearn, based in the U.K., provides classes from 67 institutions in various countries and had 970,000 active students as of May. It has offered more than 190 classes so far and has 19 courses running currently.

Most popular course: Understanding IELTS

Four hundred thirty thousand students from more than 150 countries joined this six-week class, which started in May. It focuses on skills to pass the International English Language Testing System exam, a widely accepted requirement for nonnative English speakers who are starting new jobs, immigrating, or going to universities. It is not, however, the FutureLearn course with the highest rate of participation—at least not yet. That title goes to an eight-week class on England's King Richard III, with more than 10,000 enrollees: 3,336 of them completed most of the course.

Outside Reading

"iPads < Teachers"

by Peg Tyre
Bright, April 2015

More schools are embracing technologies that give students one-on-one instruction. Can they help students in low-income households get a better education? Education journalist and author Tyre discusses some of the limitations of these new teaching methods and why schools will still need good teachers after investing in technology.

"The Upwardly Mobile Barista"

by Amanda Ripley
The *Atlantic*, May 2015

To offset the exorbitantly high costs that keep many Starbucks workers from finishing college, the company teamed with Arizona State University to reimburse employees who decide to go back to school while working part time. In an exclusive look at the first months of the program, Ripley follows some of the ambitious employees who took Starbucks up on the offer and finds mixed results.

How We Learn: The Surprising Truth About When, Where, and Why It Happens

by Benedict Carey
Random House, September 2014

An award-winning science reporter for the *New York Times* uncovers some surprising research about how our brains take in and store information, and how some counterintuitive methods can make learning easier.

The End of College: Creating the Future of Learning and the University of Everywhere

by Kevin Carey
Riverhead Books, March 2014

According to education researcher Carey, in the future a quality education will no

longer require an expensive degree from an ultracompetitive college. In this book, he explains how MOOCs are sowing the seeds of a new type of college experience he calls "The University of Everywhere," which future students anywhere in the world will access for free.

"What Are MOOCs Good For?"

by Justin Pope
MIT Technology Review, December 2014

Many of the world's best colleges now allow anyone in the world to take a class with their most renowned professors for free, thanks to the "massive open online courses" commonly known as MOOCs. But the mere fact that anyone can take a course does not mean he or she will complete it, and research has shown that the dropout rates are very high. Still, these classes continue to grow. In this review, a former Associated Press education reporter ticks off some of the benefits that MOOCs do provide.

Learning Online: What Research Tells Us About Whether, When and How

by Barbara Means, Marianne Bakia, and Robert Murphy
Routledge, March 2014

In this review of research about online learning, the authors examine what we know so far about how effective this approach is and which methods best serve different types of students and subjects.

2014 Results from the SIIA Vision K–20 Survey

by MMS Education
Software & Information Industry Association, June 2014

This report from the main trade organization for education software companies analyzes the responses of 1,000 teachers surveyed about technology trends in education. One main finding is that educators expect to see more students bringing their own devices to school. SIIA recently announced the winners of its annual CODiE awards for software developers.

Keeping Pace with K–12 Digital Learning: An Annual Review of Policy and Practice

by John Watson, Larry Pape, Amy Murin, Butch Gemin, and Lauren Vashaw
Evergreen Education Group, October 2014

This report from Colorado's Evergreen Education Group gives a state-by-state overview of education policies and tracks technology trends across private, public, and charter schools.

Grade Level: Tracking Online Education in the United States

by I. Elaine Allen and Jeff Seaman
Babson Survey Research Group and Quahog Research Group, February 2015

This report has tracked online learning in U.S. higher education for 12 years. This edition features survey results from 2,800 colleges about the virtual classes they offer, as well as educators' opinions about technology trends like MOOCs.

HarvardX and MITx: Two Years of Open Online Courses Fall 2012–Summer 2014

by Andrew Dean Ho, Isaac Chuang, Justin Reich, Cody Austun Coleman, Jacob Whitehill, Curtis G. Northcutt, Joseph Jay Williams, John D. Hansen, Glenn Lopez, and Rebecca Petersen
Social Science Research Network, March 2015

Researchers analyze two years of data from 68 MOOCs offered through edX, the MOOC partnership between Harvard and MIT.

Calendar

DEVLEARN
September 30–October 2, 2015
Las Vegas
http://www.elearningguild.com/DevLearn/content/3900/devlearn-2015-conference-expo-home/

ICDLE2015: 6th International Conference on Distance Learning and Education
October 12–13, 2015
Paris
http://www.icdle.org/

2nd International Conference on e-Learning, e-Education, and Online Training
September 16–18, 2015
Novedrate, Italy
http://eleot.org/2015/show/home

iNACOL Blended and Online Learning Symposium
November 8–11, 2015
Orlando, Florida
http://www.inacol.org/symposium/

ICERI2015: 8th Annual International Conference of Education, Research and Innovation
November 16–18, 2015
Seville, Spain
http://iated.org/iceri/

OEB
December 2–4, 2015
Berlin
http://www.online-educa.com/conference

FETC 2016 Education Technology Conference
January 12–15, 2016
Orlando, Florida
http://fetc.org/Events/Education-Technology-Conference/Information/HOME.aspx

BETT
January 20–23, 2016
London
http://www.bettshow.com/

eLearning 2016
February 14–17, 2016
Scottsdale, Arizona
http://www.itcnetwork.org/elearning-conference/general-information.html

SXSWedu
March 7–10, 2016
Austin, Texas
http://sxswedu.com/

Learning Solutions Conference & Expo
March 16–18, 2016
Orlando, Florida
http://www.learningsolutionsmag.com/lscon/content/3600/learning-solutions-2015-conference-expo-home

SITE 2016
March 21–25, 2016
Savannah, Georgia
http://site.aace.org/conf/