

THE BLOCKCHAIN REVOLUTION

& Higher Education

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hat will be the most important technology to change higher education? In our view, it's not big data, the social web, MOOCs, virtual reality, or even artificial intelligence. We see these as components of something new, all enabled and transformed by an emerging technology called the *blockchain*.

OK, it's not the most sonorous word ever, sounding more like a college football strategy than a transformative technology. Yet, sonorous or not, the blockchain represents nothing less than the second generation of the Internet, and it holds the potential to disrupt money, business, government, and yes, higher education.

The opportunities for innovators in higher education fall into four categories:

- *Identity and Student Records*: How we identify students; protect their privacy; measure, record, and credential their accomplishments; and keep these records secure
- *New Pedagogy*: How we customize teaching to each student and create new models of learning
- *Costs (Student Debt)*: How we value and fund education and reward students for the quality of their work
- *The Meta-University*: How we design entirely new models of higher education so that former MIT President Chuck Vest's dream can become a reality¹

The blockchain may help us change the relationships among colleges and universities and, in turn, their relationship to society.

Let us explain.

What Is the Blockchain Revolution?

The Internet today connects billions of people around the world, and certainly it's great for communicating and collaborating online. But because it's built for moving and storing information rather than *value*, it has done little to change how we do business. When professors send their students information such as an e-mail, lecture notes, a PowerPoint presentation, or an audio recording of a lecture, they're really sending a copy, not the original. It's OK (and indeed advantageous) for people to print a copy of their PowerPoint file, but it's not OK to print, say, money or diplomas. So with the Internet of information, we have to rely on powerful intermediaries to exchange things of value. Governments, banks, digital platforms (e.g., Amazon, eBay, and AirBnB), and colleges and universities do the work of establishing our identity, vouching for our trustworthiness, and helping us to acquire and transfer assets and settle the transactions.

Overall, they do a pretty good job—but there are limitations. They use centralized servers, which can be hacked. They take a piece of the value for performing this service—say, 10 percent to send some money internationally. They capture our data, not just preventing us from using it for our own benefit but often undermining our privacy. These intermediaries are sometimes unreliable and often slow. They exclude two billion people who don't have enough money to justify a bank account, let alone an education. Most problematic, they are capturing the benefits of the digital age asymmetrically.

What if there was an Internet of value—a global, distributed, highly secure platform, ledger, or database where we could store and exchange things of value and where we could trust each other without powerful intermediaries? That is the blockchain. Collective self-interest, hard-coded into this new native digital medium for value, would ensure the safety, security, and reliability of our exchanges online. Trust is programmed into the technology, which is why we call blockchain the Trust Protocol.

Why should you care? Maybe you're a music professor who wants artists to make a living off their art. Perhaps you're an immigrant who is sick of paying big fees to send money home so that your children can go to college in your ancestral land. Or maybe you're a parent fed up with the lack of transparency and accountability of the politicians and political appointees responsible for higher education in your state. Or perhaps you're a social media user who thinks all the data you generate might be worth something—to you—and that your privacy matters. Even as we write, innovators are building blockchain-based applications that serve these ends. And these apps are just the beginning.

It turns out that every business, institution, government, and individual can benefit in profound ways. How about the corporation, a pillar of modern capitalism? With the rise of a global

peer-to-peer platform for identity, trust, reputation, and transactions, we will be able to reengineer deep structures of the firm, for innovation and shared value creation. We're talking about building 21st-century companies that look more like networks than the vertically integrated hierarchies of the Industrial Age. The whole financial services industry is already being reinvented by the blockchain, and others will soon follow. How well does today's college or university prepare students for such a future?

How about the Internet of Things? In the not-too-distant future, billions of smart things in the physical world will be sensing, responding, communicating, sharing important data, and generating, buying, and selling their own electricity,



doing everything from protecting our environment to managing our health. It turns out that this Internet of Everything will need a *Ledger of Everything*.

One of the biggest opportunities of the blockchain is to free us from the grip of a troubling prosperity paradox. The economy is growing, but fewer people are benefiting. Rather than trying to solve the problem of growing social inequality through redistribution alone, we can change how wealth—and opportunity—is *predistributed* in the first place, as people everywhere, from farmers to musicians, can use this technology to share more fully in the wealth they create.

Blockchain, Identity, and Student Records

“Today you need an organization with endowed rights to provide you with an identity,” said Carlos Moreira of WISeKey.² This process of identification usually begins with a birth certificate issued by a state-licensed medical professional. From that day forward, the baby begins to accumulate personal data, which will include academic achievements in analog form.

The first challenge is to maintain the privacy and security of data stored digitally by those academically accredited institutions. In 2013, the Education Advisory Board (EAB) published a list of 157 strategies for collecting data about students and alumni for colleges and universities to exploit in fundraising efforts, and institutions have become good at doing so.³ When it comes to protecting these data, however, colleges and universities are no less vulnerable than other large organizations. The University of California–Berkeley, Ohio State University, the University of Wisconsin–Milwaukee, and Kirkwood Community College were among those hacked in recent years. Yale University accidentally published confidential information online, and Indiana University hosted such data on an unprotected site. The University of Utah Hospitals and Clinics, Stanford University, and the University of Miami stored data on laptops or data tapes that were later stolen.⁴

The blockchain can be programmed to record virtually everything of value and importance to humankind, starting with birth certificates and moving on to educational transcripts, social security cards, student loans, and anything else that can be expressed in code. The blockchain uses public key infrastructure (PKI) for establishing a secure platform.

PKI is an advanced form of asymmetric cryptography, where users get two keys that don’t perform the same function: one is for encryption and the other for decryption. Hence, they are asymmetric. The Bitcoin blockchain is now the largest civilian deployment of PKI in the world, second overall to the U.S. Department of Defense common access system.⁵ Sony Global Education has adapted this technology into what it is calling an open data exchange protocol, through which two parties anywhere in the world can securely share official academic records.⁶ But without the exact two keys, a hacker cannot access the data.

A second challenge to address is validity. At a time when information is abundant, fleeting, and mutable, being able to verify a job prospect’s claims is becoming increasingly important to employers. According to CareerBuilder, 57 percent of job applicants have embellished their skill set, and 33 percent have lied about their academic degree.⁷ Not

surprising, employers are wanting to see official college transcripts. However, when it comes to processing requests, universities often charge transaction fees. At MIT, for example, “the base cost for a transcript is \$8.00” with a \$2.00 handling charge for each transcript ordered online.⁸ Sony’s solution could make the transfer of such information quick and comparatively cost-free. Imagine how such a system could benefit, say, refugees who were seeking to continue their education or find a job in a new country.

A third issue is time. In the United States, only 25 percent of students attend college full-time at residential campuses. The rest are juggling work and family. These part-time students take twice as long to graduate, and only 25 percent of them actually earn a degree.⁹ Initia-

tives such as OpenBadges (<https://openbadges.org/>), Blockchain Certificates (<http://www.blockcerts.org/>), and Learning Is Earning 2026 (<http://www.learningisearning2026.org/>) are exploring ways to reward students with credentials for everything they learn, no matter the setting. If a parent teaches his or her child how to change the oil in a car, that counts (and the parent gets teaching credit). If a student learns a new skill at work, or has to collaborate to finish a task, or is managing others, that goes on the learning transcript too. The MIT Media Lab started hashing digital certificates onto the blockchain to permanently denote membership and to reward community members for their valuable contributions to the lab’s work.¹⁰ Students are not getting just a grade; they are getting a credential, which they can put to use immediately on the job market.

Blockchain and the New Pedagogy

As long as society—or at least today’s employers, including governments—values existing credentials, and students will pay to get those credentials at recognized institutions of higher education rather than pursue alternatives, then the college/university will remain a gatekeeper to opportunity.

But the credential and even the prestige of a higher education institution are rooted in its effectiveness as a learning institution. If colleges and universities become seen as places where learning is inferior to other models or, worse, as places where learning is restricted and stifled, then the role of the campus experience and the credential itself will be undermined. Attending a college or university is too costly to be simply an extended summer camp.

Campuses that embrace the new models become more effective learning environments and more desirable places. Computer-based learning, for instance, can free up intellectual capital—on the part of both professors and students—to spend their on-campus time thinking, inquiring, and challenging each other, rather than just absorbing information.

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If there is one thing that's due for innovation in higher education, it's the model of pedagogy. To start with, big universities are still offering the broadcast model of learning, in which the teacher is the broadcaster and the student is the supposedly willing recipient of the one-way message. It goes like this: "I'm a professor, and I have knowledge. Get ready; here it comes. Your goal is to take this data into your short-term memory so that you can recall it to me when I test you."

The definition of a lecture has become the process in which the notes of the teacher go to the notes of the student without going through the brains of either. This is no longer appropriate for the digital age and for a new generation of students who represent the future of learning. Young people want to converse when they learn. They like to share. Immersed in digital technology, they are keen to try new things, often at high speed. They want their education to be fun and interesting. So they should enjoy the delight of discovering things for themselves.

It's true that colleges and universities are trying to update this broadcast model—through essays, hands-on labs, and even seminar discussions. And of course, many professors are working hard to move beyond this model. However, it remains dominant overall. The professors who remain relevant will have to abandon the traditional lecture and start listening and conversing with the students. To begin, students could achieve the mastery of knowledge (anything where there is a right or wrong answer) by working with interactive, self-paced computer learning programs outside the classroom, freeing students and faculty alike to spend class time on the things that matter: discussion, debate, and collaboration around projects.



We also need to be clear on the purpose of higher education. It's not about skills, and to a certain extent, it's not even about knowledge. What counts these days is the capacity to learn throughout life; to research, analyze, synthesize, contextualize, and critically evaluate information; to apply research in solving problems; and to collaborate and communicate.

So how can blockchains help? Consider the case, noted above, of Vitalik Buterin, the founder of the Ethereum blockchain. Like many teenagers, Buterin "spent ridiculous amounts of time on the Internet," reading about different ideas that were heterodox, out of the mainstream.¹¹ Ask him which economists he likes, and he rattles off Tyler Cowen, Alex Tabarrok, Robin Hanson, and Bryan Caplan. He can speak on the works of the game theorist Thomas Schelling and the behavioral economists Daniel Kahneman and Dan Ariely. "It's actually

surprisingly useful how much you can learn for yourself by debating ideas like politics with other people on forums. It's a surprising educational experience all by itself," he said. The topic of bitcoin, he noted, kept coming up.

"I had all these different interests, and somehow bitcoin seemed like a perfect convergence. It has this math. It has its computer science. It has its cryptography. It has its economics. It has its political and social philosophy. It was this community that I was immediately drawn into," he said. "I found it really empowering." He went through the online forums, looked for ways to own some bitcoin, and discovered a guy who was starting up a bitcoin blog. "It was called *Bitcoin Weekly*, and he was offering people five bitcoins to write articles for him. That was around four dollars at the time," Buterin said. "I wrote a few articles. I earned twenty bitcoins.

I spent half of them on a T-shirt. Going through that whole process, it felt almost like working with the fundamental building blocks of society." How many students have that experience in college?

By the end of that year, Buterin was spending ten to twenty hours a week writing for another publication, *Bitcoin Magazine*. "When I was about eight months into university, I realized that it had taken over my entire life, and I might as well let it take over my entire life. Waterloo was a really good university and I really liked the program. My dropping out was definitely not a case of the university sucking. It was more a matter of, 'That was fun, and this is more fun.' It was a once-in-a-lifetime opportunity, and I just basically couldn't let it go." He was only seventeen years old.

Buterin is a natural-born leader, in that he pulls people along with his ideas and his vision. Shouldn't the university experience cultivate these assets rather than get in the way of them?

In 2011, the technology entrepreneur and investor Peter Thiel launched his two-year fellowship program for "young people who want to build new things" (<http://thielfellowship.org/about/>). Thiel's target audience consists of students who "skip or [drop] out of college to receive a \$100,000 grant and support from the Thiel Foundation's network of founders, investors, and scientists." The approach is similar to Buterin's: students learn by working on something they care about, such as clean water. Thus far, Thiel Fellows have started more than 60 companies with a combined value of \$1.1 billion. Blockchains provide a platform for such collaboration, not just tracking people's individual contributions but also rewarding them for results.

A good model for classroom collaboration is Consensus Systems (ConsenSys), one of the first Ethereum software-development companies. It is breaking new ground in management science along the lines of *holacracy*, a collaborative rather than hierarchical process for defining and aligning the work to be done. Among those holacratic

tenets are “dynamic roles rather than traditional job descriptions; distributed, not delegated authority; transparent rules rather than office politics; and rapid reiterations rather than big reorganizations,” all of which describe how blockchain technologies work.¹² How ConsenSys is structured, how it creates value, and how it manages itself differs not only from the typical classroom but also from the typical online course.

For the most part, members of ConsenSys choose two to five projects to work on. No top-down assignments. There is no boss. Everyone owns a piece of every project directly or indirectly: the Ethereum platform issues tokens that members can exchange for Ether and then convert into any other currency. The goal is to achieve a balance between independence and interdependence. For the classroom, the watchwords are *agility*, *openness*, and *consensus*: identify what needs to be learned, distribute the load among the students eager and able to do it, agree on their roles, responsibilities, and rewards, and then codify these rights in smart contracts. Teachers and students alike would need training to participate in such a system.

Blockchain and Costs (Student Debt)

Many educators have a problem with the idea of education as big business, and yet companies like Pearson and McGraw-Hill make their fortunes by providing the classroom content, additional teacher training, classroom and school administration systems, and the testing content and platforms—the results of which lead to credentials, not just of high school diplomas and college entrance but of individual licensures and professional certifications. These companies have considerable budgets for lobbying federal and state legislators.

Let’s look at the numbers. From 1995 to 2015, the average tuition and fees at private colleges and universities increased 179 percent. Tuition and fees for out-of-state students at public universities jumped 226 percent, and

How Blockchains Establish Trust

Digital assets—everything from money, stocks, bonds, and intellectual property to music, art, loyalty points, and student records—are not all stored in a central place: they’re distributed across a global ledger, using the highest level of cryptography. When a transaction is conducted, it’s posted globally, across millions of computers. Around the world is a group of people called miners who have massive computing power at their fingertips—10 to 100 times bigger than all of Google worldwide. Every 10 minutes, kind of like the heartbeat of a network, these miners assemble all the transactions from the previous 10 minutes into a block. Then the miners compete to solve a tough problem; whoever solves the problem gets to validate the block and receives some digital currency as a reward. In the case of the Bitcoin blockchain, the winner gets Bitcoin.

Then that block is linked to the previous block and to the block before that to create a chain of blocks. Every block is time-stamped, kind of like with a digital waxed seal. So if you wanted to hack a block and, say, send the same Bitcoin to several people, you’d have to hack that block, plus all the preceding blocks, through the entire history of that Bitcoin on the blockchain—not just on one computer but across millions of computers, simultaneously, all using the highest levels of encryption, in broad daylight. Tough to do. This is infinitely more secure than the computer systems that we use today.

The Bitcoin blockchain is just one of many. For example, the Ethereum blockchain was developed by a twenty-two-year-old Canadian named Vitalik Buterin. Ethereum has some extraordinary capabilities and tools. For example, it enables programmers to build smart contracts, agreements translated into lines of computer code that handle the enforcement, management, performance, and payments of contracts between people. On the Ethereum blockchain, there are projects to create a replacement for the stock market and a new model of democracy, where politicians are accountable to citizens.

in-state tuition and fees ballooned by 296 percent.¹³ Approximately 44 million Americans owe a grand total of \$1.3 trillion in student loans. A member of the Class of 2016 racked up, on average, \$37,172 in debt.¹⁴ It’s no wonder that cost of a college education was such a hot issue in the 2016 U.S. presidential election.

Melanie Swan is looking to the blockchain to tackle student debt head-on. She is the founder of the Institute for Blockchain Studies. She has been working on MOOC accreditation and “pay for success” models on the blockchain. The blockchain provides three elements toward this goal: (1) a trustable proof-of-truth mechanism to confirm that the students who signed up for Coursera classes actually completed them, took the tests, and mastered the material; (2) a payment mechanism; and (3) smart contracts that could constitute learning plans.

Consider smart contracts for coding

skills. “Why don’t we target financial aid toward personal development?” Swan said.¹⁵ It works like the microfunding organization Kiva, but Kiva for coding classes rather than for entrepreneurial startups; everything would be super transparent, and students would be accountable for their progress. Donors—such as companies that need specific skills—could sponsor individual students, put money toward learning goals, and pay out according to achievement. Let’s say you wanted to support a female student who lives in Nigeria and is going through Google’s Training for Android developers (<https://developer.android.com/training/>). Every week this student would need to provide proof of completion of a development module. Perhaps this is all automated through an online test where the blockchain confirms the student’s identity and records progress¹⁶ before disbursing the next week’s funding—into what we could call the student’s

“smart wallet for higher education”—so that the student could continue paying for college courses without interference. This could all be accomplished without a not-for-profit or government agency with administrative costs and the power to change funding. “Money toward a girl’s education couldn’t be diverted to her brother’s schooling,” Swan said.

The visionaries behind the Learning Is Earning initiative, such as Jane McGonigal, in partnership with the Institute for the Future (<http://www.iftf.org>) and the ACT Foundation (<http://actfdn.org/>), envision “teach it forward” schemes in which students can pay down their student loans by teaching other students what they just learned or by applying this new knowledge immediately in the job market.¹⁷ They needn’t wait for a degree to begin earning money. Employers—or other students or professors—will be able to query the blockchain for people with the particular combination of skills and knowledge needed immediately on the job or in the classroom. In other words, the blockchain will help employers match projects with the proven capabilities of students available for project work. Students will be able to link these earnings with a particular lecture or skill so that they can calculate the precise value of each element of their training and development. Likewise, human resources personnel will be able to calculate the return on their training and development investments. Employers may even be willing to pay for a student’s entire education in exchange for a cut of the student’s future earnings. Academic publishers may be willing to pay for some of this tracking data to improve their learning modules for all types of learners, since they won’t have access to it otherwise on the blockchain.¹⁸

The Blockchain and the Meta-University

The phrase *ivory tower* usually carries pejorative connotations. From the 19th century, it has been used to designate a world or atmosphere in which intellectuals engage in pursuits that are dis-

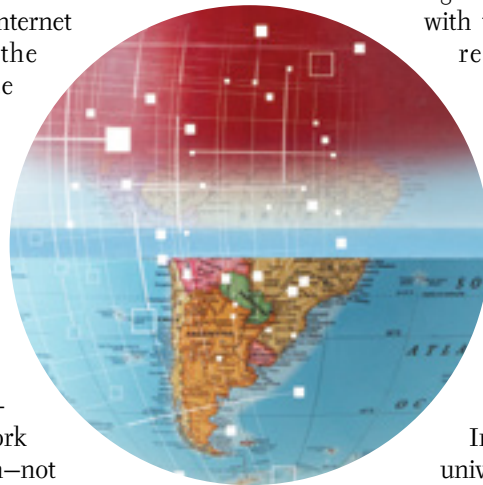
connected from the practical concerns of everyday life. For cynics, it connotes a willful separation from the everyday world; esoteric, overspecialized, or even useless research; and academic elitism, if not outright condescension. If we set aside some of these more negative associations, the ivory tower metaphor still captures one of the key flaws in today’s system of higher learning: in a world of unprecedented connectivity, especially among today’s youth, colleges and universities continue to operate as largely autonomous islands of scholarship and learning and have thus far failed to use the Internet to break down the walls that divide institutions, professors, parents, and students.

The blockchain will enable the 21st-century institution of higher education to disaggregate into a network and an ecosystem—not a tower. Indeed, innovators have an enormous opportunity to create an unparalleled educational experience for students globally by assembling the world’s best learning materials online and enabling students to customize their learning path with support from a network of instructors and educational facilitators, some of whom may be local and some halfway around the globe. To make this work for students, colleges and universities will require deep structural changes, and educators will need to embrace the partnerships. In 2006, MIT President Emeritus Vest offered a tantalizing vision of what he called the *meta-university*. In the open-access movement, he saw “a transcendent, accessible, empowering, dynamic, communally constructed framework of open materials and platforms on which much of higher education worldwide can be constructed or enhanced.”¹⁹ The web would provide

the communication infrastructure, and a global open-access library of course materials would provide much of the knowledge and information infrastructure. Dr. Vest argued that a noble and global endeavour of this scale would speed the propagation of high-quality education and give teachers and students everywhere the ability to access and share teaching materials, scholarly publications, and scientific works in progress and to participate in real-time science experiments.

However, without a means of associating students’ identities with their achievements, recording and credentialing these achievements over time, rewarding constructive and collaborative behavior in the community, and otherwise holding participants accountable for deliverables, this Internet-only meta-university would still fall short of traditional education. An average of only 15 percent of students who sign up for MOOCs complete them; free MOOCs are still considered supplemental to tuition-based online courses from traditional colleges and universities.²⁰

The blockchain provides a rich, secure, and transparent platform on which to create such a *global network for higher learning*.²¹ We envision three stages. The first is content exchange. Professors share ideas and upload their teaching materials to the Internet for others to use freely. The second is content co-innovation, where teachers collaborate across institutional and disciplinary boundaries to co-create new teaching materials using wikis and other tools. By stage three, the college or university has become a node in the global network of faculty, students, and institutions learning collaboratively. It still maintains its



identity, campus, and brand. The global network for higher learning is not a pipe dream. Leading scholars know that higher education institutions and their faculties cannot continue to operate as islands, constantly reinventing the lecture.

Stage 1: Content Exchange

The lowest level of collaborative knowledge production is simple content exchange: colleges and universities post their educational materials online, putting into the public domain what would have traditionally been considered a proprietary asset and part of the institution's competitive advantage in the global market for students. MIT pioneered the concept, and today more than 200 institutions of higher learning have followed suit as part of MIT's OpenCourseWare initiative (<https://ocw.mit.edu/>). OpenCourseWare solves the problem of isolation and provides a wealth of materials that others can use and even build on, regardless of their institutional affiliation.

We're talking about not only textbooks and digital books but also lecture notes, assignments, exams, videos, podcasts, and so on. Professors and students will need better tools for gauging the quality and suitability of various assets, and students will want some evidence of effort to carry forward. Using capabilities like smart contracts, blockchains provide a means of tracking and rewarding each party's contributions. Users can do more than "like," "upvote," or share a piece of content; they can send its creator some tokens of value that might be used, say, to support research assistance or grant writing. Members of the worldwide academic community will have incentive to contribute their intellectual property, know-how, and insights not just to improve higher education but also to enhance

their own reputations and even to receive material or financial benefit. Newcomers will be able to see not only the most used content relevant to their studies but also the most valued contributors. For-profit academic journal and textbook publishers can participate in, rather than intermediate, value creation.

Stage 2: Content Co-Innovation

The next level in collaborative knowledge creation goes beyond discussing and sharing ideas to the actual *co-creation* of content. Just as Wikipedia's distributed editors collaborate to create, update, and expand the online encyclopedia's entries, so too could professors co-innovate new teaching material, publish this newly synthesized content, and share in the recognition and rewards.

A case in point is Wikiversity (<https://en.wikiversity.org/>), a project of the Wikimedia Foundation. Rather than offer a set menu of courses and materials, Wikiversity

participants set out what they want to learn, and the Wikiversity community collaborates, in multiple languages, to develop learning activities and projects to accommodate those goals. Imagine what a platform like Wikiversity could do with a token system to reward collaborative behavior! That's what the blockchain supports. It enables the community to identify valuable projects, assemble teams of collaborators, and fund each phase of development, rewarding collaborators according to their contributions.

In this scenario, psychology professors would work together to design the "perfect course" that pools the collective knowledge of the world's leading thinkers in the field. Of course, participants would not agree totally on course contents, since there are various perspectives, schools of thought, and teaching techniques. But as in Wikipedia, the professors could work globally to create core,

generally agreed-upon modules, and then subnetworks of like-minded teachers could develop ancillary elements. For the ultimate course, the teachers would need more than course materials—they would need course software allowing students to interact with the content, supporting small-group discussions, enabling testing and scoring, and issuing badges for completion.

If thousands of people can develop Linux (<https://www.linuxfoundation.org/>), the most sophisticated computer operating system in the world, they can certainly develop the tools for a psychology course. Indeed, many well-known open-source software projects are already under way in the academic community. One of the most popular is Sakai (<https://sakaiproject.org/>). Built by educators for educators, Sakai facilitates collaboration in and across courses, research, projects, administrative processes, and multidisciplinary and multi-institution efforts. Creation of the software itself is a product of content co-innovation. In turn, the product helps users co-innovate content that educators can teach to students. We need more projects like this.

Used properly, blockchain platforms could support such collaboration directly with students too. Rather than simply receiving the professor's knowledge, the students could co-create knowledge with light supervision—one of the most effective methods of learning—and get credit for their co-creation.

Stage 3: Global Network

The upshot could be a disaggregation of institutions of higher learning. The digital world, which has trained young minds to inquire and collaborate, is challenging not only the lecture-driven classroom but the very notion of a walled-in institution that excludes large numbers of people. Why not allow a brilliant ninth-grader to take first-year college math, without abandoning the social life of his or her high school? Why use the concept of grades and grade matriculation at all? Why not encourage a foreign

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student majoring in math to take a high school English course? Why is the college or university the unit of measurement when it comes to branding a degree? In fact, in a networked world, why should students have to assign their “enrollment” to a given institution, akin to declaring loyalty to some feudal fiefdom?

In this vision of a global network for higher learning, a student receives a custom learning experience from a dozen institutions, while the blockchain serves to track the student's path and progress. The student enrolls in his or her primary college and is assigned a *knowledge facilitator*, who works with the student to customize a learning experience, the

lems. The blockchain harmonizes and aggregates the records of various institutions for each skill learned and each module completed, steadily building an individual student's list of achievements.

Of course, such open platforms could provide a means to address the needs of all learners, not just traditional college-age students. For today's knowledge workers, remaining truly competitive in fast-moving fields of research and innovation means constantly retraining and retooling to begin or continue their working lives in a modern, dynamic, and technology-focused environment. The cost of building new continuing education programs from scratch could

publishing industry provides much of the classroom curriculum, the administrative and engagement platforms, and the testing programs for credentialing at all levels of academic achievement. So if you're an academic or an administrator, you might say: “Let the publishers rethink the student experience. Why should I bother? I have enough on my plate.”

Indeed, there are few incentives to change—except that the new model of higher education is in the best interest of learners. Faculty and administrators alike should consider what has happened to other cultural institutions that have resisted change. Encyclopedias, newspapers, record labels, and colleges/



journey, and outcomes. The student might enroll in the primary college in Oregon and register to take a behavioral psychology course from Stanford University and a medieval history course from Cambridge. For these students, the collective syllabi of the world form their menu for higher education. Yet the opportunity goes beyond simply mixing and matching courses. Next-generation faculty will create a context whereby students from around the world can participate in online discussions, forums, and wikis to discover, learn, and produce knowledge as a community of learners who are engaged directly in addressing some of the world's most pressing prob-

lems. The blockchain harmonizes and aggregates the records of various institutions for each skill learned and each module completed, steadily building an individual student's list of achievements. Of course, such open platforms could provide a means to address the needs of all learners, not just traditional college-age students. For today's knowledge workers, remaining truly competitive in fast-moving fields of research and innovation means constantly retraining and retooling to begin or continue their working lives in a modern, dynamic, and technology-focused environment. The cost of building new continuing education programs from scratch could

Incentives to Change

If all this innovation is a good idea, what are the incentives to change? Why should professors adopt a new model of pedagogy? Tenure continues to prop up the lecture model. The U.S. pub-

lications industry provides much of the classroom curriculum, the administrative and engagement platforms, and the testing programs for credentialing at all levels of academic achievement. So if you're an academic or an administrator, you might say: “Let the publishers rethink the student experience. Why should I bother? I have enough on my plate.” Indeed, there are few incentives to change—except that the new model of higher education is in the best interest of learners. Faculty and administrators alike should consider what has happened to other cultural institutions that have resisted change. Encyclopedias, newspapers, record labels, and colleges/

universities have a lot in common. They are all in the business of producing content. They all recruit, manage, and compensate capable producers. They all offer proprietary products, and they take legal action against those who infringe their intellectual property. Because they create unique value, their customers pay them, and they have revenue. All of these businesses are possible because of scarcity—in quality news, information, knowledge, learning, art.

Today, the businesses of encyclopedias, newspapers, and record labels are in various stages of collapse. Because of the Internet, they've lost their monopolies on the creation and curation of quality

content. The digital age brought abundance, mass participation, new delivery channels, and new business models. The Internet erased their allegedly unassailable attributes faster than you can transfer bitcoin from one phone to another. In each sector, only two or three global behemoths remain.

Colleges and universities have not yet lost their monopoly on academic credentialing and educational brands. But again we have a case of an irresistible force (i.e., the reinvention of higher learning) meeting an immovable object (i.e., the old paradigm). As soon as one of the blockchain-based innovators demonstrates that its approach to learning will pay off more quickly, that employers value its credentials as much if not more, and that it can deliver real value to the great many students who cannot afford college

tuition or whose cognitive or social abilities don't "fit" traditional pedagogy, then rest assured: students will demand more for their money than what they are receiving from traditional institutions of higher education.

Why not be leaders for a new paradigm? The blockchain provides a rich, secure, and transparent platform on which to create a global network for higher learning. We believe that higher education works best when it works for all types of teaching and learning, and we believe that this new platform is an engine of inclusion. Let's use the emerging Internet of value and the blockchain revolution to recapture our identities and endow them with our detailed and real-time records of learning. Perhaps then we can finally reinvent the past model of pedagogy and transform the architecture

of higher education for the future generation of lifelong learners. ■

Notes

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4. "World's Biggest Data Breaches," *Information Is Beautiful* (updated January 5, 2017).
5. Andreas M. Antonopoulos, interview with the authors, July 20, 2015. Antonopoulos is the author of *Mastering Bitcoin* (2014), *The Internet of Money* (2016), and with co-author Gavin Wood, *Mastering Ethereum* (2017).
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8. MIT Registrar's Office, Transcripts, accessed January 8, 2017.
 9. Complete College America, "Time Is the Enemy," September 2011.
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 14. "A Look at the Shocking Student Loan Debt Statistics for 2017," *Student Loan Hero*, accessed January 8, 2017.
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 18. See the Institute for the Future's *Learning Is Earning 2026*.
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 20. Katy Jordan, "MOOC Completion Rates: The Data," last updated June 12, 2015; "State of the MOOC 2016: A Year of Massive Landscape Change for Massive Open Online Courses," *Online Course Report*, accessed January 24, 2017.
 21. The term *global network for higher learning* was first developed by Don Tapscott and Anthony D. Williams in their book *Macrowikinomics: New Solutions for a Connected Planet* (New York: Portfolio Penguin, 2010). See also Don Tapscott and Anthony D. Williams, "Innovating the 21st-Century University: It's Time!" *EDUCAUSE Review* 45, no. 1 (January/February 2010).
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