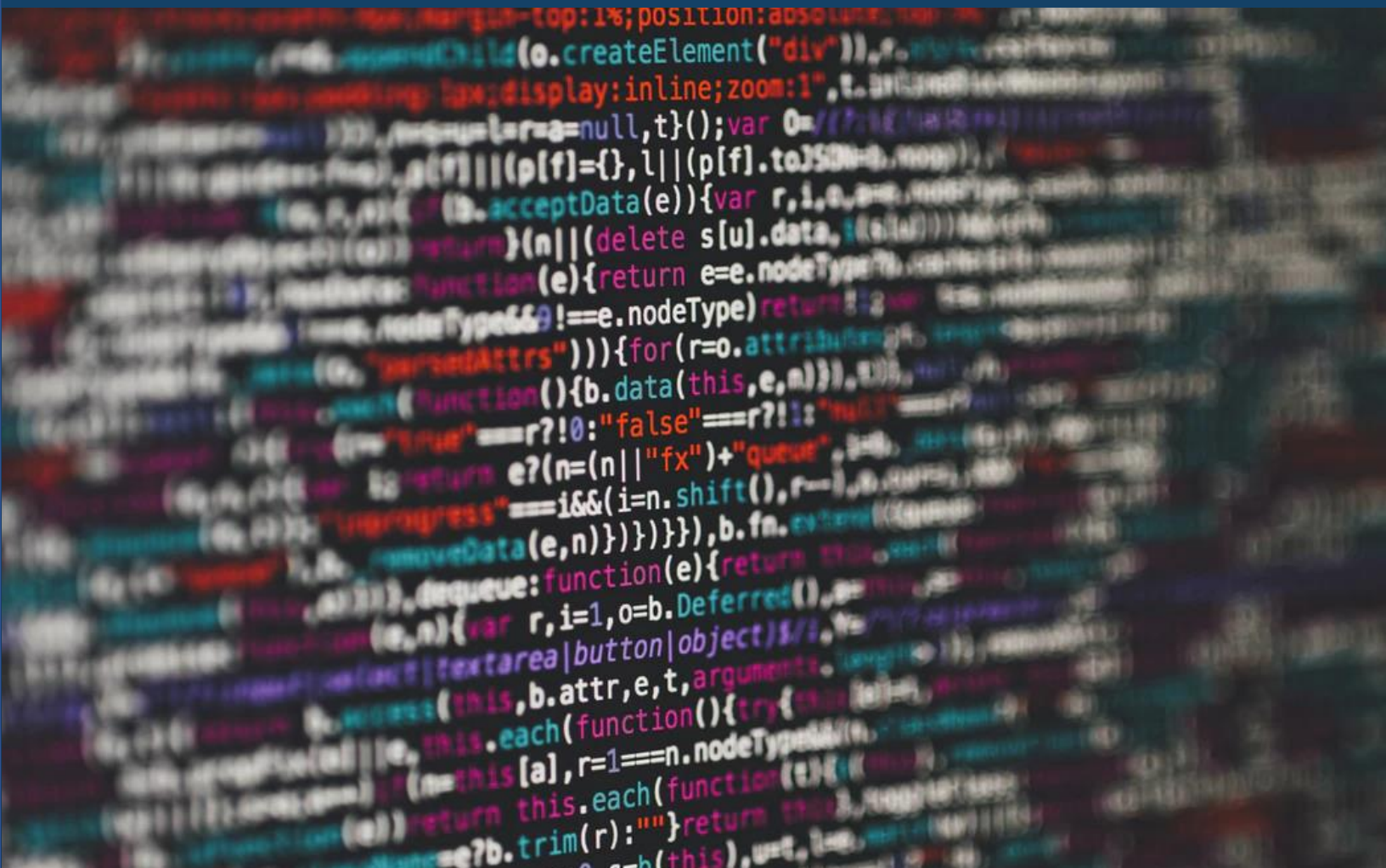
ACADEMIC IMPRESSIONS

Leaving a lasting mark on higher education

THE BLOCKCHAIN

A REVIEW OF THE OPPORTUNITIES FOR HIGHER ED



ABOUT ACADEMIC IMPRESSIONS

Academic Impressions is a professional development firm that helps institutions of higher education build the capacity of their people and develop the next generation of leaders. We provide in-depth professional development opportunities, such as conferences, on-campus workshops, and an all-access membership to hundreds of online trainings, reports, and job aids. All of our professional development resources are designed specifically for higher education by vetted higher education experts. We also partner with institutions to benchmark their culture of professional development against a sector-wide average and develop customized learning plans to develop their next generation of leaders.

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ACKNOWLEDGMENTS

We would like to thank all people who dedicated their time to speak to us as part of this research. Special thanks to Tobe Phelps, Ari Juels, Sharon Sputz, Michael Mathews, and Gillian Chu for contributing so many of their thoughts and expertise.

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OVERVIEW

"Blockchain is the next generation of the Internet that designs trust, personalization, security, and integration to all worldwide data. It has the sophistication to blend the best of artificial intelligence, mix realities, machine learning, deep learning fluidity, and the Internet of Things for full personification of intelligence."

– Michael Mathews, Chief Information Officer, Oral Roberts University[i]

THE HIGHER-ED CONTEXT

On average, college students will now attend three or more institutions before receiving a degree. Yet the current system for storing student data is designed and operates on the assumption that students will stay at one place for four years, that they will learn all the qualifications they hope to present as potential future job candidate from that one institution, and that this institution will always be in existence. There are several flaws in that assumption:

- We know that most students attend multiple institutions (often spread out over time).
- Other forms of non-formal learning are sometimes just as crucial in advancing skill sets.
- Unfortunately, some institutions have not been able to adapt to the rapidly changing landscape for higher education—and have ceased to exist.

All three of these circumstances can make it quite difficult for a student to gather their own data when they need it. In a recent interview with us, Phil Komarny, the former chief digital officer at the University of Texas and current vice president of innovation at Salesforce, suggests that as a society, we are starting to think of data as a "31st human right" – meaning that our data is our own property; we should know where it exists, have access to it, and know who *else* has access to it.

The current model of higher education is both resilient and persistent; many of the same structures have endured since the middle ages. But as we move through the digital revolution, existing systems are proving inadequate to meet students' (and others') needs. Current data sharing causes friction because of the need of an intermediary (in this case, a higher-ed institution). It can take days to process a student transcript or months to process potential applicants. Also, in a time of limitless data, we often do not know what is the "master copy" of any piece of data, or what data is even accurate. To demonstrate that point, Natalie Smolenski, vice president of business development at Learning Machine, estimates that over half of Ph.D.'s are purchased or falsified. Potential employers also have a hard time verifying graduates' experiences, whether these be formal learning, non-formal learning, or previous work experiences—in part because of the multiplicity of organizations where this data needs to be checked. Especially as we move to a learning model that is increasingly global and lifelong in nature, the days of having to verify data *at just one institution* are gone. Storing accurate data and making it easily verifiable has become a real issue.

As "lifelong learning" becomes the norm, we know that the average person will need to reskill or change careers multiple times in the future. The old system of tracking academic records does not allow for that. We're also seeing a growing disconnect between higher ed and the workforce in their perception of how prepared graduates actually are.[ii] While most provosts and even most students themselves say that they are well prepared for the workforce, most employers don't agree. Similarly, the majority of graduates later express regret about their choice of major or about other aspects of their higher education[iii]—though given the time commitment and the price tag attached to postsecondary studies, it is difficult for many to think about going back.

So, what is a solution to all of these problems? Many would say that solution lies with a technology called the blockchain. This realization is only coming slowly to higher education. While there are a few institutions that are truly innovating with blockchain technology—and we will interview a number of them in this research brief—overall, these represent only a tiny percentage of higher-ed institutions. And even those early adopters say that not everyone at their institution is on board or sees the potential. Nationally, the U.S. is not making strides in blockchain research as quickly as other countries. In Malta, Bermuda, and some European nations, governments are providing either extensive funding to drive blockchain initiatives or are starting to put policy in place. In the U.S., investment in blockchain research is more scattered and is mostly coming from corporate start-ups and a few nonprofit institutions. According to Lindsay McKenzie in *Inside Higher Ed*, the blockchain is "growing fast in the business world and universities—and colleges are responding. Many professors are incorporating blockchain into their teaching, and several universities have developed full courses devoted to the technology."[iv]

Also, when media sources discuss research institution's "adoption" of blockchain technology, this can mean anything from basic implementations such as digital management of courses and diplomas to more aspirational initiatives around providing open learning across institutions.

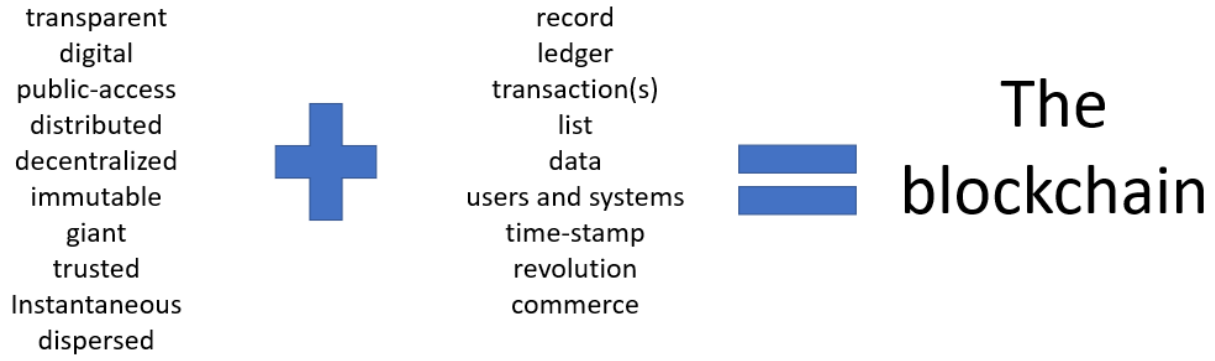
What blockchain technology does is get rid of the notion that institutions operate as siloed entities, involving them instead as part of a larger system of transactions.

But if a growing body of experts hope that the blockchain will have the potential to transform higher education, what *is* the blockchain?

What Is the Blockchain?

Most people know it simply as the technology behind cryptocurrencies like Bitcoin or Ether—but it is so much more than just that. The technology itself been around for about a decade but is only just starting to make headway outside of the tech industry. And higher education is a sector that not only stands to benefit from this technology but will also likely play a key role in continuing to develop wide scale usability.

We've come across so many ways to describe blockchain technology that we wanted to demonstrate how you can literally mix and match the numerous adjectives and nouns to describe blockchain in the following diagram:



So what *is* the blockchain?

"Trustless Commerce in a Trusted Way"

Blockchain is the underlying technology of cryptocurrencies, but it has potential for use far beyond this application. The blockchain has been described as the new internet and the next generation of data and information. Phil Komarny describes it as a digital ledger that allows data to be dispersed across different users and user systems via cryptography that allows for "trustless commerce in a trusted way." That means you do not have to know the person on the other end of a transaction to trust that the transaction is secure and permanent; the technology in place take care of that for you.

In the digital age, data verification and security are a huge challenge What is so game changing about blockchain technology is that unlike the internet, which is great for *exchanging* information, the blockchain can be used to verify information.

How the technology works is that a smart contract that involves complex algorithms is created and agreed upon by all users in a network, also known as a node, to place orders or data transitions. To do this, users in a node are charged what is called a gas fee. All paying computers within a node are set up to handle blockchain transactions. For instance, when an institution assigns a student a blockchain diploma, the institution pays a fee and writes a transaction that is recorded on the digital ledger. All computers in the node must record and verify the transaction, which continually adds a "block" to the "chain" of previous transactions. In this way, transactions are fully transparent, permanent, and distributed. The security comes from the algorithms; all computers in the network agree that a transaction is a good via what is known as consensus algorithms. If there were to be a bad transaction, it would easily be traced to the computer that made it. The blockchain is described as nearly impossible to hack because you would have to change the transaction on every single computer's digital ledger within a node (which could be mean thousands, maybe millions of digital ledgers). This process is described in the diagram from BlockGeeks[v] that you will see on the next page.

This idea of a *ledger*, which is used to determine who owns something and their sequence of transactions, is crucial to understanding the blockchain. The ledger is a really ancient tool that has existed in one form or another almost throughout recorded history; now, we're just thinking about it in a digital form. *Blockchain in Education,* a 2017 paper[vi] by the JRC Science for Policy Report for the European Commission, noted that throughout the ages, recordkeepers (whether a bank, government institution, credit bureau, or university, etc.) have exercised influence, power, and even control over transactions to such a point that monetary systems, land ownership, and accumulation of wealth in business are simply have not been possible without a third party to

track and verify the transactions. Theoretically, the blockchain has the potential to disrupt these longstanding social structures, because the blockchain can be used to verify transactions at a personal level, company/institutional level, and industry level. To cite one example at the industry level, IBM now "has 1,500 employees working on more than 500 blockchain projects in industries like shipping, banking, healthcare and food safety. It also has forged partnerships with the likes of Columbia University to develop still more uses for the tech."[vii] Walmart is also experimenting with blockchain technology to track food from other countries so they can trace outbreaks and contain them.

Christian Catalini, Associate Professor of Technological Innovation, Entrepreneurship, and Strategic Management at MIT describes higher ed and other industries as being in the "infrastructure building phase" right now, where we are starting to see economics, market design and computer science intersect in interesting ways. According to Gartner's Hype Cycle for Emerging Technologies,[viii] most cutting-edge technologies that use the blockchain are climbing the peak and have not reached their productivity plateaus.

However, in an interview with us, Mike Matthews, the chief information officer at Oral Roberts University, shared that the basic concept of blockchain technology has already been proven by the US Library of Congress' use of MARC codes, which are used to ensure that each item exists as only one entity and that there is only one copy that can be utilized at a time. There is still a lot to be figured out with blockchain technology, but as Matthews put it, "it will be, because the notion of trust and the amount of data that exists for everything is what will continue to propel blockchain technology forward."

SUMMARY

What about blockchain makes it a "gamechanger"? For one, it provides everyday people with the ability to be self-sovereign over personal data. The one word that we continued to hear throughout our research was "trust." Due to the blockchain's decentralized, immutable, and transparent nature, we can be highly confident that any transactions are safeguarded by a complex and nearly impossible-to-hack infrastructure. This is because in order for a transaction to take place, each party needs to enter that transaction according to agreed-upon criteria (e.g., complex algorithms). Once a block has been added onto the "chain," it can never be modified or deleted. This means absolutely everything is traceable. With all of these decentralized and distributed "record keepers" in place, the blockchain removes the need to trust third parties and controlling governing bodies (e.g., banks, government institutions, higher-ed institutions) to serve as secure keepers of transactions and personal data.

BRINGING THE BLOCKCHAIN TO HIGHER ED

3 Domains

According to the Joint Research Centre's report for the European Commission, "education, with some minor exceptions, is not currently perceived to be high on the agenda of most countries with national blockchain initiatives … currently stakeholders within education are largely unaware of the social advantages and potential of blockchain technology."

However, in the United States and Canada, there are three primary domains in which higher-ed institutions are beginning to work with blockchain technology. These are: *research, curriculum, and commercialization*.

1. Research

Many in higher education are working to further scholarly and rigorous research about the complexities of data sharing and transparency—and how this emerging technology can be applied. Several institutions (among them Stanford, Columbia, MIT, and others) have set up blockchain research centers that aim to overcome the many challenges facing wider implementation, userability, and commercialization of blockchain technology. Because of these centers, the higher education sector will play a pivotal role in making the blockchain applicable, scalable, impactful, and sustainable.

Areas of research at these centers include:

- Scalability
- Finding ways to achieve higher throughput without undermining security and trust
- Confidentiality (given that one benefit of the blockchain is transparency, there are privacy features that need to be worked out)
- Verifiable delay function (by which we mean reducing the time for transactions and correcting erroneous transactions)

The blockchain research happening at academic institutions will have a big impact on practitioners, and it is what will make it possible in the future to connect this new technology with industry.

2. Curriculum

The goal here is to develop curriculum around the technology and get newer generations involved in the future of data sharing. More institutions are starting to offer blockchain courses and certificates. This will, in turn, address one of the prevailing challenges with continuing to develop blockchain technology—namely, the lack of expertise and available talent to implement blockchain at institutions and within industry. Students today are eager to learn about the underlying technology, so interest in these classes is high when they are offered, even though students frequently register with misconceptions about what the blockchain technology is and does. While those involved in blockchain education describe growing interest, it's important to note that the level of blockchain education that institutions are offering at this point is mostly introductory, and conceptual rather than practical.

3. Commercialization

University-industry partnerships are of course of high interest, but there is a lot yet to be determined about that is possible and practical. As more research into blockchain technology is published, those institutions who are partnering with industry to research and pilot blockchain applications—for example, Columbia University, in its partnership with IBM—will be in a better position to identify applications that support licensing and commercialization.

The ultimate goal here is to remove the control of third parties that restrict access to individuals' information, cause friction in data sharing, and introduce errors in the accuracy of shared data. The notion of a digital ledger has implications for how information of all kinds is stored and shared (e.g., diplomas, learning and work experiences, healthcare records, etc.). In this space, one tech company called Learning Machine is making early headway in higher education by partnering with institutions to create customizable templates for blockchain technology.

5 Real-World Applications for Higher Ed

The reason *this* research brief is timely is because even though there is still a lot that needs to be figured out, these three domains (research, curriculum, and commercialization) in which higher education is investing in the blockchain are all beginning to yield real-world applications. These applications include data management, credentialing, financial aid, intellectual property, and curriculum and teaching. The following table briefly describes these five.

1	**DATA MANAGEMENT** "Digital identity" is now being thought of as a basic human right. Blockchain technology would allow individuals to have control over their own personal data and would eliminate the need for costly data management systems and personnel. Digital transformation of paper-based tracking systems would increase efficiency and control over data sharing between individuals, units, and institutions.
2	**CREDENTIALING** As higher education moves toward a model of lifelong learning and upskilling to help students keep up with a changing world, we need new ways of *verifying* both formal and informal learning. Blockchain would allow for immediate and accurate verification, no third party needed. Theoretically, it would be possible to track down professional and education achievements via the blockchain, in a standardized way.
3	**FINANCIAL AID** Some higher-ed institutions are starting to explore alternative financial options, such as allowing students to pay tuition using cryptocurrency like Bitcoin or Ether. Another idea—perhaps a little further down the road—involves allowing repayment contractors (such as employers) to set up a transaction whereby the student's contractor does not pay tuition up front, but guarantees payment in the future.
4	**CURRICULUM** Most people have no expertise in blockchain technology. With userability being a challenge, many institutions are starting to offer courses, bootcamps, and even degrees in blockchain or cryptocurrency. Teaching blockchain technology requires truly interdisciplinary learning, because it combines elements of business and commerce, IT and cryptography, policy and law, etc.

5	**INTELLECTUAL PROPERTY** Historically, higher-ed institutions have often served as both the preservers of and the gatekeepers to knowledge. The blockchain makes possible the idea of the "meta university." Professors would be able to track the usage of their intellectual property, making their content open via the blockchain but undeniably tied to the rightful owner. This has implications for open and collaborative learning that can easily transcend the boundaries of a single institutional entity.

9 Challenges to Address

Most would agree that we are still in the early days on the adoption curve, but that it will pick up. Because the blockchain is still in its infancy, big challenges include commercial application and user experience for those who are not engineers and IT scientists. There needs to be ease of use for the public to understand the technology and have ways to use it in the form of a standard system that scales across industries. For many, the biggest challenge right now is simply the uncertainty of the unknown. Much of the potential for the blockchain hinges on the creation of software that does not yet exist and data standards that have yet to be imposed at national and international levels. Within higher education, many are simply unaware of the potential benefits of the blockchain.

Given that context, throughout our research on the early adoption of the blockchain in higher education, our contacts described the following ten most frequent challenges.

1. Scaling

The blockchain was designed to be slow and methodical because of its decentralized nature, which is what makes it a secure system. Consider this context: On average, Visa handles 2,000 transactions per second and can scale up to 50,000. Bitcoin, however, can process only 7 transactions per second. Not only is that rate miniscule in comparison, but that processing consumes enormous amounts of electricity (more than the entire country of Switzerland, as Ari Juels at Cornell informed us).[ix] While the rate of transactions is slower than other systems, adoption of blockchain would still vastly speed up current processes that institutions have in place. Mike Matthews, the CIO at Oral Roberts University, offered us this comparison: On average, it takes 8 days for an institution to validate and admit a student. The same process would take hours (and that's being conservative) using blockchain technology.

2. Privacy

Questions about confidentiality are already rising. Although the blockchain is a very secure system, because it stores personal and transaction data, individuals naturally have questions about who would have access to that data in an open, decentralized infrastructure. Given that *transparency* is one of the main values of the blockchain, its permanent and immutable nature opens particular questions around privacy. Researchers will need to balance transparency with confidentiality. Some say the solution requires private blockchains, in order to limit the pool of people who can be nodes on a network. Others say this defeats the point of the blockchain. Their argument is: if you have a trusted secure infrastructure, let that work and don't add closed layers on top of it. But questions remain: How will the system ensure that only higher-ed institutions are allowed permission on their network?

3. Security of Smart Contracts

In theory, the blockchain's extreme security is assured because of the ability to create secure smart contracts and ensure that everyone within a node is working according to the smart contract. However, our contacts repeatedly cautioned that there are still bugs to work out in developing secure smart contracts. Poorly created contracts have resulted in the theft of hundreds of millions of cryptocurrencies dollars. One challenge is that the level of expertise needed to develop secure smart contracts is often beyond the scope of what ordinary developers can do. Mike Matthews at Oral Roberts University suggested, "The best security features are the ones that the user does not see. A success story would be that people do not know that the application they are using is enabled by blockchain technology."

4. Governance Models

How do people in a network come to a consensus on protocol changes? This is important because all transactions are done by way of an agreed-upon protocol and a set of criteria. Everyone has to be doing the same thing, and similarly, everyone has to consent to a change or a new protocol. Within large networks, you can see how this would be challenging. For adoption of the blockchain to become widespread in higher education, the question of how to structure and, when needed, modify the governance model for a network is going to be important to address.

5. Expertise

Blockchain curriculum is popping up all over the place, but its depth and comprehensiveness is sometimes questioned. According to Gillian Chu, head of education at Blockchain@Berkeley, many schools teach the *theory* behind blockchain technology, but what students are lacking is context and understanding of the ecosystem in which the technology would be situated—in other words, the real-world applications. One thing is certain: institutions that are offering a blockchain curriculum are seeing a huge demand. Berkeley had over 400 applicants for a course.

6. Hype

New technology frequently arrives surrounded by considerable hype. There are reasons that this can be a good thing, but it also creates challenges of its own, because people who are eager to study or use the technology may not be sensitized to the significant limitations that still exist. Blockchain technology has the potential to transform many industries, include higher education, but according to the experts we spoke with, many of the *proposed* applications do not make sense. When they do, the technology is often not there yet. Amid all the public hype, the limitations are not often talked about.

7. Userability and Real-World Application

Efforts to bridge blockchain technology to real-world applications are in their infancy—and the reasons for this are clear. As Phil Komarny, formerly of the University of Texas and now vice president of innovation at Salesforce, quipped, right now you need a "shitload" of engineers and IT people to use blockchain technology. On the other hand, Mike Matthews at Oral Roberts University notes that Amazon is only a few years out from developing blockchain templates (much like MS Word templates) that will give the average person who has no programming knowledge the ability to use blockchain applications. Theoretically, in a few years, we will be able to put student information into an Amazon cloud and use a blockchain template to manage transactions, rendering redundant many existing processes and infrastructures that we have in place.

8. Misconceptions

Phil Komarny at Salesforce calls this "cryptoconfusion." Most people only know about Bitcoin and are unable to envision the potential of the blockchain beyond cryptocurrencies. And some

worry about the impact that artificial intelligence and the blockchain on jobs. Where do human beings fit into this new tech? Natalie Smolenski, vice president of business development at Learning Machine, helps provide perspective. She notes that the blockchain *verifies* information very well, but what the blockchain cannot do without humans is screen for the quality of the data that is being verified. For example, the blockchain will not replace a university registrar, but it would completely change the system in which the registrar works. The blockchain would help a university safeguard their brand against fraud more efficiently.

9. Unprecedented Surveillance

Some have also raised the concern that with this technology, there might be potential for it to be misused; the opportunity to exercise surveillance and control over monitoring data is unprecedented. As Natalie Smolenski at Learning Machine put it, "The importance of digital self-sovereignty is that the individual has ownership of their data and can choose how and when to self-disclose." Yet this could potentially be undermined in a system where data is transparent and distributed.

For all of these challenges, it will take time to learn more and build out solutions, and the learning curve is further complicated by the fact that there is a higher barrier of entry in terms of the expertise needed.

3 INTERVIEWS

What *are* early adopters in higher education doing? We conducted three additional in-depth interviews with leading thinkers in this space at several postsecondary institutions:

- Central New Mexico Community College
- Columbia University
- University of California-Berkeley

These quick case studies represent a diversity of institution sizes and types – from large state institution to private university to community college – and a variety of initiatives from the use of blockchain to handle student records, to corporate partnership, to a blockchain curriculum for students.

What follows is what the people involved in these initiatives shared with us.

CENTRAL NEW MEXICO COMMUNITY COLLEGE

In the U.S., CNM is leading blockchain adaption in many ways. It was a strategic priority for the college to facilitate the increase of student-owned technology. They chose blockchain as a technology that reflected that goal. All CNM graduates have the option to get their diploma via blockchain because it is readily verifiable and no additional cost to student or future employer. We spoke recently with Tobe Phelps, their senior director of IT innovation.

Q. We know your blockchain initiative started as a pilot. What kind of progress have you seen since?

A. We did start as a pilot. We started by issuing certificates to our deep-dive coding student cohorts. These were about 10-12 students every 9 weeks or so. Since then we have gone into full production. Every student that gets a diploma or certificate from CNM has the opportunity to get those credentials through blockchain. This has come specifically because of an organizational goal of seeking opportunities to empower our students with more student-owned technology. Since the deployment of what we refer to as our revision 1 technology and adoption, we have started to look at what Blockchain 2.0 will look like for the college. This search has led us to a partnership with IBM and various other organizations that are working together to create a credentialing infrastructure based on the hyperledger standard. We are

hoping to take student owned credentialing to the next level and provide greater value to our students.

Q. If other institutions are interested in piloting a blockchain initiative, what steps should they take to get started?

A. I would suspect that most people would focus on the technology to answer this question. I would head the other direction. The technology is the easy part. I would say that first thing that you need to do as an institution is to decide to have the courage to proceed. This is still new and leading-edge technology and it is not something that will come easy to many organizations. There will need to be some decisions made about funding, policy, and most controversially revenue. The institution needs to understand the implications of making credentials student-owned. For us, we knew going in that there would likely be a reduction in revenue as fewer students would need certified copies of credentials as they could use their blockchain credentials. We know that students will probably never shy away from paper diplomas for display, but the need for certified copies to send to employers might go down.

Q. Tobe, what response are you seeing so far from students and employers?

A. I think this is the most surprising part. We started our journey with very little advertising. When as student received a certificate or diploma a simple email was sent out inviting them to download the mobile wallet and accept their diplomas or certificates through blockchain. There was not much in the way of explanation about the technology, but we have seen a great acceptance rate from our students. The more amazing part is that we are seeing employers accepting these documents without much effort. We have seen that the reputation of the college transfers right over to blockchain credentials without many questions. While we have no way of tracking these interactions, we have great anecdotal evidence that our local employers are embracing the new technology.

Columbia University

In a partnership with IBM, Columbia created the Columbia-IBM Center for Blockchain and Data Transparency. The center has three purposes: conduct innovative research on data sharing techniques and technologies, develop curriculum for students, and support the commercialization of ideas emerging from student and faculty research. The center includes an innovation accelerator to incubate these ideas.

We spoke with Sharon Sputz, director of strategic programs at Columbia's Data Science Institute, and Dmytro Pokhylko, who heads the Columbia Lab-to-Market (L2M) Accelerator Network, a cross-discipline support system providing strategic and tactical guidance to Columbia-affiliated accelerators. Here is what they shared with us:

Q. Could you tell us more about the breadth of efforts in the Columbia-IBM Center for Blockchain and Data Transparency?

A. The Center was set up as a comprehensive effort and not as a narrowly defined mandate or initiative.

Within the **curriculum** track, we issued a call for proposals to launch new coursework at Columbia (and which may also provide online components). We already have four new courses on blockchain and its applications, introduction to blockchain and cryptocurrency, introduction to blockchain technology, etc. Courses can be proposed by multidisciplinary teams of faculty and by faculty in partnership with experts at IBM. We have faculty participating from the business school, the school of public affairs, the law school, and the engineering school. This multidisciplinary approach to curriculum is especially important to us because data transparency coursework is really about learning data sharing techniques and technologies.

Within the **research** track, we've launched fundamental research, we've held workshops (such as one on Internet of Things and blockchain) and are planning more, as well as surveys, thought leadership, and whitepapers.

In our first year, we awarded three initial research projects:

- DeepSEA framework for certified smart contracts.
- Machine learning and the economics of knowledge production—which is really at the heart of our work. Data can be looked at as a natural resource. It used to be that you valuated a company based on its manufacturing capacity. Then we shifted to a service economy. Now, as we shift yet again, we have to learn how to valuate companies when the new currency is data. How do you value data as tangible capital?
- Incentive-compatible protocols for blockchain.

We're now in the second year, and we have awarded new projects.

For the **accelerator**, we are seeking real-world applications that showcase the strengths of the blockchain and data transparency. For example, we are incubating projects for managing personal data in healthcare, DNA curation, real estate certification, food supply chain

management, and others. These projects are proposed typically by a cohort of both undergraduate and graduate students who provide a whitepaper describing the proposed application and why they feel it is unique and worthy of pursuit. The accelerator combines elements of lean launch pad methodology, mentorship, technical workshops, and ignition funding to help them validate whether this project is worth pursuing at this time as a real-world, commercial application. We select approximately ten teams on an annual basis and support them in conducting customer interviews, creating a minimal viable product, crafting their pitches, etc. We are careful to expose them to multiple ecosystems and partners (including IBM), and our role is to help assess and validate the opportunity and provide the cohort with tools for seeking commercial viability.

Q. As you've taken this partnership from concept to execution—to the point where you've now awarded a second year of proposals—what has surprised you along the way? What opportunities have come up that you didn't anticipate?

There are many more connections emerging from this partnership than we had hoped for or imagined. It has been amazing to see all of these unintended consequences that have been positive. For example:

- Our researchers have formed new networks and relationships across disciplines.
- IBM has sent experts to speak at events on campus (such as our distinguished lecture series).
- Our researchers have visited the IBM campus.
- Local business and municipal representatives have reached out to our incubator cohorts as potential investors or mentors—people with a natural interest in the real-world applications we're accelerating.

These are activities that have been made possible because of this relationship, beyond the original scope of our partnership. These connections are happening because we're bringing people together.

Q. What is something you hope for and anticipate as you look toward a third year?

We're approaching the moment when we can plan a showcase event and share the tangible outcomes of our work. We've increased the number of students getting educated in these areas, we are able to publish papers, and we will see the impact of the cohorts we've prepared to take their innovations out into the world. We will soon be able to showcase concrete outcomes, and that's very exciting.

University of California-Berkeley

A student-led group called Blockchain @ Berkeley was the first student-run blockchain organization in the country. They've fostered a community in the Bay Area in many ways, running world-class conferences that have hosted the likes of Vitalik Buterin himself, research and development with professors on active problems in blockchain (sometimes leading to startups), partnering with the UC Berkeley Sutardja Center for Entrepreneurship and Technology to open an accelerator, contributing to open source projects, and consulting for Fortune 500 companies and even the World Bank. Berkeley also offers several courses on blockchain technology, but the first was a student-run course that once taught over 200 students.

We reached out to Gillian Chu. Reflecting back on her time as the head of education at Blockchain@Berkeley (she has since retired from the executive board), here's what she shared with us:

Q. From the perspective of a student-led blockchain initiative, what would be your advice to other student organizations trying to lead a blockchain initiative?

A. Keeping people inspired is harder than it looks. Finding like-minded people and getting them excited about the material is important, but learning about a new subject, especially when there aren't a whole lot of established resources through a university, can be difficult.

If you're pioneering an effort like this at your school, your greatest hurdle will be getting everyone to a stage where you can all sit down and have productive conversations that critique the field. Reaching out to other university groups (like B@B) can have productive results, but the efforts still have to come from within the student group. Setting up a student organization is never easy, but realize that when you cross this initial hurdle, and have a pipeline for getting people up to speed, the real trick will come in getting them to learn and push forward on their own, exploring the areas that interest them best.

Besides listening to your members, and helping them work towards their goals, there's not necessarily any new advice. Talk to your members about their incentives, and make sure they're working on things that further their own interests, in addition to the interests of the club. There are lots of interesting areas when it comes to blockchain, and we've helped everyone from MBAs, to JD students, to MD students, to BA/BS undergrads in a variety of disciplines find their niche within the blockchain community.

Q. What do you see as the biggest obstacle to getting students involved with blockchain?

A. The biggest hurdle to student involvement in past years was information accessibility. Imagine trying to learn something about a field where much of the information is siloed and difficult to comprehend -- a few books written about the field. We've tried to overcome that by releasing our material and lectures online, and we even managed to convince Berkeley to lend their name to an edX course. We get emails from people all over the world trying to access our materials, and it's great to see our material travel so far.

Now that material is more widely available, the problem is accessibility to students who go looking for the material. There's a lot of very dense and technical material there, and it can be very intimidating. University workloads only ever seem to get heavier, and devoting a significant portion of your time and energy to understanding a new field can be frustrating without mentors with whom you can discuss the material. A real understanding of blockchain can't be obtained from taking any one course -- it takes effort on the part of the student to internalize the material and problem-solve.

Q. What has been the biggest "win" so far, with Blockchain@Berkeley?

A. Honestly, every year has brought a new surprise—from the first client we ever signed, to the largest client we've ever signed, to a wide reaching edX course, to setting up an accelerator, to running our first conference, to alumni very successfully funding their startups, to securing big grants for the University. There are also more personal wins—seeing alumni go on to lead very fulfilling and successful lives within the blockchain ecosystem, being able to teach someone all the skills they need to get a job, having the opportunity to travel the world to talk about blockchain, finding lucrative work for friends that paid their way through college.

I've been lucky to be around for lots of these "big" moments, but I'd honestly say I think our biggest "win" is the longevity of the club. We just graduated out fourth cohort of seniors, and every new cohort seems more motivated than the last. It looks like Blockchain @ Berkeley will be around as active contributors for a few years yet.

[i] Michael Mathews, quoted in "Blockchain Essentials: A 25 Years Reflection through the Internet and Digital Age." https://www.govtech.com/education/higher-ed/Blockchain-Essentials--A-25-year-reflection-through-the-Internet-and-Digital-Age.html

[ii] See the National Association of Colleges and Employer's Job Outlook study for the class of 2018: https://www.naceweb.org/job-market/trends-and-predictions/job-outlook-fall-recruiting-for-the-class-of-2018/

[iii] See PayScale's Salary Survey report. June 25, 2019. https://www.payscale.com/data/biggest-college-regrets

[iv] McKenzie, Lindsay. "Blockchain Gains Currency in Higher Ed." Inside Higher Ed, August 13, 2018.

[v] Rosic, Ameer. "What is Blockchain Technology? A Step-by-Step Guide For Beginners." BlockGeeks, 2017. https://blockgeeks.com/guides/what-is-blockchain-technology/

[vi] Grech, Alexander and Anthony F. Camilleri. *Blockchain in Education*. JRC Science for Policy Report for the European Commission. 2017. https://publications.jrc.ec.europa.eu/repository/bitstream/JRC108255/jrc108255_blockchain_in_education(1).pdf

[vii] Garcia, Ahiza. "IBM is betting big on blockchain technology. Is it worth the risk?" *CNN Business*, September 12, 2018. https://money.cnn.com/2018/09/06/technology/ibm-blockchain-gamble/index.html

[viii] Panetta, Kasey. "5 Trends Emerge in the Gartner Hype Cycle for Emerging Technologies, 2018." *Smarter with Gartner,* August 16, 2018.

[ix] Ari Juels, Tech Professor and codirector of Initiative for Crypto Currencies and Contracts, Cornell University.

QUESTIONS OR COMMENTS?

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We would love to continue the conversation.